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FROM THE ORBITAL CAPTURE
TO SOME TYPES OF L.E.N.R. REACTIONS

Abstract

In this article the process is discussed by which an orbital electron happens to be on the nucleus and is captured by a quark up of a proton of the nucleus itself, which for what becomes a quark down.

It is assumed that the involvement of virtual particles allows the nucleus to determine whether, having enough energy available, the process, in which they are part the weak interaction and the strong interaction, can be completed.

A parallel process can be considered for certain types of observed reactions LENR, starting from the reduction of the hydrogen atom to the condition of "miniatom".

Lino Daddi - FROM THE ORBITAL CAPTURE

TO SOME TYPES OF L.E.N.R. REACTIONS

K - CAPTURE

The reaction of nuclear capture of one of two K-shell electrons by the nucleus $Nu_{Z,A}$ can be written:

$$Nu_{Z,A} + e^- = Nu_{Z-1,A} + \nu. \qquad (1)$$

Denoting by $M_{Z,A}$ and $M_{Z-1,A}$ the masses of the initial and final nuclei, it will $E = [M_{Z,A} - M_{Z-1,A}]\, c^2$ the available energy from the process. The energy of the emitted neutrino is:

$$\varepsilon_\nu = E + m_e c^2 - \varepsilon_k, \qquad (1\,')$$

being ε_k the electron energy on the K orbital (which may often be overlooked in these assessments). If the energy E is insufficient, the capture (1) does not happen, so the nucleus does not undergo the beta decay of type K capture. This, however, is not directly observable, but:

1 - measuring the recoil momentum received from the nucleus, or

2 - observing X-rays following the rearrangement of the electronic layers.

It should be noted that the K electron should not be on the nucleus because it was attracted by the Coulomb force. This force is actually the one that "keeps" the electron in the orbital K. If this were to bring the electron to the nucleus it do make a work, and the electron would arrive with much more energy. But the energy remains that ε_k of the orbital K, because the electron moves to the nucleus by fluctuation of its distance from it, according to the probability admitted by quantum mechanics, according to the Uncertainty Principle (U.P.).

In ref [1] it is assumed that the probability of capture is the product of the probability f of an electron K be in the nucleus for the probability q that an electron, having attained the nucleus, is captured by the nucleus itself. The fact that there are very strong differences in the half-lives of the various nuclei that decay by orbital capture can be considered as an indication that q is very dependent on the nucleus structure.

Among the typical nuclei that show orbital capture we can remember ^{40}K and ^{136}La, which are very different examples of instability, as the ^{40}K almost stable (half-life of billions of years) and ^{136}La very unstable (half-life of 9.5 min). So the picture is more complex than could result from a simple positional fluctuation.

Recall that ,according to U.P., two particles in contact, which by their nature should fuse but can not do so for lack of energy, may temporarily act as a virtual particle. The permanence in the life of the virtual particle is given by:

$$\Delta t = \hbar / \Delta E \qquad (2)$$

where ΔE is the energy deficit.

Thus, if the energy is insufficient, the system of two particles in the left hand side of (1) can be considered as the virtual nucleus $Nu_{Z-1, A}$.

Table 1 shows, from first to third line, the presumed evolution of the three phases.

In the phase 2 the (1) can be seen as a reaction

$$p + e^{-} = n + \nu \qquad (3)$$

of one of the Z protons of the nucleus. Until the mass difference is acquired between neutron and proton in the nucleus , the neutron can not be formed, and the system (p,e) of Fig.1 can be considered as "virtual" neutron. This can become real after the exchange of W bosons, made possible by having received the necessary energy ΔE. In the final phase of table 1 the electron is interacting with a quark up of a proton in the nucleus, converting it into a quark down. The Fig. 2 illustrates the situation at the level of quarks before the exchange of W. But now we're talking about a different system: no more (p,e) subject to the Coulomb force, but (quark up,e) subject to the weak force.

TAB.1 - THE PHASES OF THE K CAPTURE

Pre-fusion phase	Expected fusion [virtual particle]	Working interactions and their effect
1 - K electron on nucleus $Nu_{Z,A}$	nucleus + electron [virtual nucleus $Nu_{Z-1,A}$]	Coulomb force
2 - K electron on the proton	Nuclear proton + electron [virtual neutron]	The strong interaction supplies energy from nucleus rearrangement
3 – K electron inside the proton	Quark up + electron [virtual quark down]	The weak interaction changes a quark up into a quark down

Phases 2 and 3 of Table 1 can be viewed as one phase consisting of two processes.

In order to the K capture occurs, it is necessary that the rearrangement of nucleons (promoted by the strong interaction) makes available the necessary energy.

This is the chronological succession :

I) The K electron goes on the nucleus, but it is unknown whether the capture is energetically possible;

II) To explore the possibility of capture, the electron form a virtual neutron with a proton;

III) You may think that the nucleus to rearrange itself by replacing the proton with the virtual neutron as if this was real. So the nucleus $Nu_{Z,A}$ would become the nucleus $Nu_{Z-1,A}$ and the energy E would be made available by the rearrangement;

IV) If this is sufficient, the exchange of W bosons (not yet in the case of Fig. 1 and Fig. 2) takes place , and a neutrino is emitted (Fig. 3).

But of course the final transformation is on Stage 3 of the Tab. 1, as illustrated in Fig.2.

It seems difficult to separate the effects of the strong and weak interaction. The hypothesis of the virtual particles, as an interim step, may reduce this difficulty.

Fig.1 : Virtual neutron

e = K electron

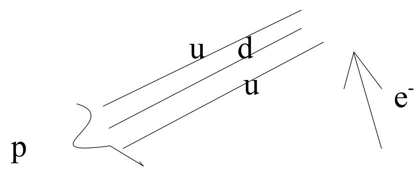


Fig.2 : Virtual quark down

e = K electron

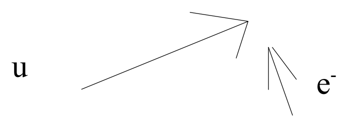
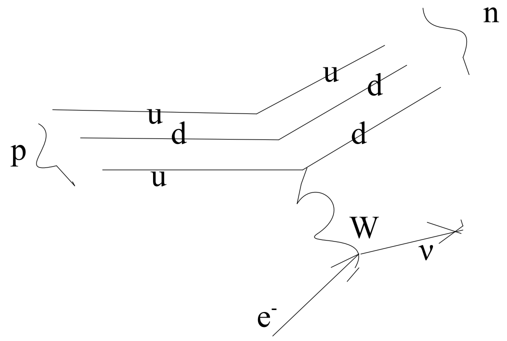


Fig.3 : K capture

p belongs to nucleus (Z,A)

e = K electron



This is, of course, a process which affects not only the nucleus, but involves the whole atom. The orbital capture, however, seems more likely event than the capture of an electron met by chance. When atoms are fully ionized (as in supernovae) the capture can not occur.

In the few cases (such as, for example, ^{64}Cu and ^{74}As) in which a nucleus can decay in three ways: beta minus, beta plus and orbital capture, its disintegration constant λ is unique. It is in fact equal to $\lambda = \lambda_1 + \lambda_2 + \lambda_3$, λ_1 being the constant of β^- decay, λ_2 the constant of β^+ decay and λ_3 that of the orbital capture.

But a temporary presence of a K electron on the nucleus is considered to be possible for the nuclei of all atoms. Ultimately all nuclei have the possibility of capture an orbital electron to convert a proton into a neutron, but only those able to obtain energy from the restructuring (as defined in the point III of the chronological order) have this type of beta decay.

THE CASE OF 'HYDROGEN - THE MINIATOM

Even the electron of the hydrogen atom can be found in the nucleus, that is, on the only proton. This event has a low probability of occurring but this, according to CONTE [3], could be greater than you think. However it is suitable the atom be in unbound state. The atomic state (or nascent) hydrogen is rare in nature but can be achieved under specific conditions, for example when hydrogen is absorbed by metals that favor molecular dissociation. Nickel is one of them, but so are zirconium, titanium and tungsten.

The capture of the electron could be achieved as indicated by Fig. 3; but that was designed meaning that p was one of the protons in the nucleus $Nu_{Z,A}$ which undergoes K capture. But the presence of electron on the proton greatly reduces the atomic dimension, up to nuclear dimensions, so the atom becomes a "miniatom" (p, e). It is understood that the miniatom is still an atom, consisting of separate proton and electron interacting via the Coulomb force. It would be inappropriate to consider it now as virtual neutron. By itself, the miniatom has not the energy to become real neutron (the rearrangement of the three quarks is not sufficient). Since, however, the nucleus consists of a proton, the steps 1) and 2) in Table 1 coincide. It is essentially a neutral particle, able to approach a nucleus without suffering the Coulomb repulsion. If it encounters a nucleus $Nu_{Z,A}$ may react with it, but its short life limits the likelihood of such reaction.

The nucleus $Nu_{Z,A}$ could capture the entire miniatom in two different ways, A) and B).

A) as virtual neutron, pending the energy made available by rearrangement of $Nu_{Z,A+1}$. This would be equivalent to the capture (n, γ) of a thermic neutron with the excess energy derived from the rearrangement of the nucleus $Nu_{Z,A+1}$.

B) with separate proton and electron capture. The steps of this mode are presented in Table 2.

The nucleus $Nu_{Z,A}$ could confine himself (according to line 2) to capture the proton of the miniatom (p, e) ; that is generally an exothermic reaction. But (line 3-a) it can absorb the electron of the miniatom. Also this process would be equivalent to the capture (n, γ) of a thermic neutron

Finally, it should also consider the possibility that $Nu_{Z+1,A+1}$ is beta radioactive for K capture.

TAB. 2 – SEPARATE ELECTRONIC CAPTURE FOR HYDROGEN IN A SOLID

Phase 3a and 3b are alternative	Expected effect	Working interactions
1 – Electron of the H atom is on the proton	Miniatom (p,e) formation	Coulomb interaction
2 - Miniatom mets a nucleus $Nu_{Z,A}$ of the solid	$Nu_{Z,A}$ captures the proton of miniatom, forming $Nu_{Z+1,A+1}$	Nuclear interaction restructures $Nu_{Z+1,A+1}$(which may remain excited)
3 a – $Nu_{Z+1,A+1}$ captures at once the electron of the miniatom	After conversion of one of its quark up in quark down	Weak interaction changes a quark up in quark down
3 b - The new nucleus $Nu_{Z+1,A+1}$ captures an electron K of the atom (*)	After conversion of one of its quark up in quark down	Weak interaction changes a quark up in quark down

(*) The K capture may be replaced by beta plus emission.

With the hypothesis of miniatoms and virtual neutrons some of the reactions LENR, such as those mentioned, for example, in a review of STORMS [4] could be justified. To keep in mind an article of MILEY [5] on the possibilities offered by virtual neutrons.

OTHER PROPOSALS OF MINIATOMS

The formation of a hydrogen miniatom may also occur in other way, different from the U.P.,giving access all the same to A) and B) modes as well as to phases 2 or 3 of Tab.2. Below are a number of the proposals.

According to STREMMENOS [6] do not hydrogen atoms, but protons are spread in the defects of crystal structures, in particular Ni. Thanks to the positive charge they capture electrons to form unstable miniatoms and would soon be absorbed by nuclei of Ni. Their size ($<10^{-14}$ m) allows a corresponding approach, to make up the predominant nuclear forces of cohesion.

The miniatom of MILLS [7] is called hydrino, and is expected by the Grand Unified Theory of Quantum Mechanics (CQM) developed by the author himself, who still denies a role of hydrino in cold fusion and LENR processes. The heat produced in its reactor would be due to hydrinos formation. The technique to produce hydrinos involves the use of a catalyst (potassium or strontium ions) and monoatomic hydrogen.

DUFOUR [8] instead has developed the hydrex, that would be formed in solids permeated of hydrogen under the effect of intense electromagnetic fields. It would be accounted by the weak nuclear force and its half-life would be a few days. A recent evolution of the virtual neutron concept was named "hypole".

HEFFNER [9] calls "deflated state of Hydrogen" the miniatom. He proposed that there would be "briefly but frequently. " It could promote fusion process between two hydrogen nuclei, but also processes LENR between hydrogen and nuclei belonging to the solid. In the second case the interaction is weak, and it is rather infrequent, since the nucleus is unstable and its life is too short. But the rearrangement of the nucleus could give additional time the overall process.

WIDOM and LARSEN [10] presented a LENR theory based on the capture of an "heavy" electron by a proton. A neutron is generated of ultra low momentum "(ULM) and a neutrino. The ULM neutron is absorbed by a nucleus, resulting in a beta emitter.

Some of the cases here reported enable a miniatom life much longer than that assessed with U.P. Consequently, the frequency of LENR reactions may be greater and be compatible with a heat played more abundant. In particular could justify, at least in part, the exothermal reactions observed in Ni-H systems by PIANTELLI [11] and, recently, by FOCARDI and ROSSI [12] with theirs "Energy Catalizer".

Even with deuterium, which can undergo the reaction

$$d + e = n + n + \nu \qquad (4)$$

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. The production of a temporary dineutron corresponds to an hypothesis formulated by RUSSELL [13] several years ago.

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