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Hydrogen Miniatoms

Some LENR/CF Scientists [1 2 3 4 5] assert that, in metal-hydrogen systems, p+e fusion, by forming neutrons, may be a precursor of processes capable of producing the many new nuclides observed in several experiments. The basic mechanism would consist in neutron captures and possible subsequent beta decays.

The reaction :

$$p + e \Rightarrow n + \nu \qquad (1)$$

is endoergic, with a 0.78 MeV threshold, but is very improbable: the calculated cross-section is of the order of 10^{-20} barn [5].

Virtual neutrons

We can consider the possibility of a virtual neutron[2 6], that is of an occasional couple in which the electron is very near by the proton with kinetic energy, even less than the threshold of the (1). Near a nucleus it could be captured becoming a real neutron. Indeed neutron capture is almost always strongly exoergic, so it can overcompensate for the energy lacking in the real neutron synthesis:

$$\begin{cases} p + e \Rightarrow n_{virt} + \nu \\ n_{virt} + {}^{A}N \Rightarrow {}^{A+1}N \end{cases}$$

and the total reaction could be :

$$p + e + {}^{A}N \Rightarrow {}^{A+1}N + \nu \qquad (2)$$

which also may be written as ${}^{A}N\,(pe, \nu)\,{}^{A+1}N$.

The virtual neutron mechanism was also proposed by Dufour[7], who in particular considered the hydrogen fusion, obtained putting A=1 in Eq.(2) :

$$(3) \qquad p + p + e \Rightarrow d + \nu$$

or also p (pe,ν) d , the Q-value of which is 1.44 MeV, (equal to the difference between the binding energy of the deuteron and the threshold energy for the neutron synthesis). Dufour admitted that nearly all the energy is carried away by the neutrino, while the deuteron carries only the recoil energy (~ 1 keV).

The virtual neutrons mechanism would be able to explain by itself some cold fusion experiments in which the observed effects can be attributed to neutrons produced by the p+e synthesis , and they seem generated as slow neutrons. But when the total cross-section appears much greater than the expected one, a more complex mechanism has to be identified, like the miniatom formation. In fact, the miniatom formation makes the proton stay very near to the electron for a relatively long time, with a great increase of the probability of the observed reactions that would be determined by the neutron capture cross-sections and by the efficiency of the miniatom formation.

Miniatoms

Some Researchers [8] [9] [10] [11] [12] [13] adopted the hypothesis a proton and an electron can form hydrogen "shrunken atoms" (hydrogen miniatoms), as also a deuteron and an orbital electron can form deuterium miniatoms, with the electron nearer the nucleus compared to the Bohr radius, at new energy levels, even very deep. They could be formed under conditions which aren't the same in the various theories (not all requiring a crystal lattice). The question of the compatibility of such compression with the uncertainty principle is not always tackled. I don't known if this difficulty may be overcomed by the fact that the miniatoms are temporary formations

Very compressed miniatoms should behave as neutrons in crossing the matter; so they could come nearer up the nuclei, with which could undergo absorption processes.

A my paper[14] contains a review of about ten proposals on miniatoms. To them, the theory of Spence[15] should be added: He shown, by a QED calculation, that resonance of long life time (s), nuclear dimensions (fm) and low energy of formation (eV) could exist.

For the hydrogen miniatom Dufour [7] adopted the name of "hydrex", whereas Mills [12] adopted the name of "hydrino". A quarrel on the priority may be found in Infinite Energy[16] . Among the theories on miniatoms we can quote those of Mills[13] and Conte[16].

Hydrogen miniatom capture

If a neutron is not formed before , on the target nucleus the proton of the miniatom could be captured by the nucleus (proton capture, or cold fusion by tunneling). The process is generally exoergic; indeed it was considered by various Authors also as possible energy producer. The formed nucleus (intermediate nucleus) so is characterized by (Z+1,A+1) numbers; it should be of stable type, but now it is in an excited state[17]. The most simple case, that now we consider, is when the proton capture is followed neither by emission of some particle (that should take a part of the energy, so subtracting it to nucleus and to the following reaction) nor by fission.

Vysotskii[18] reported at ICCF9 the observation of the proton capture $p+{}^{133}Cs={}^{134}Ba$ inside particular biologic cultures.

Alcali-hydrogen reactions ,were observed by Bush[19] starting from 1992.In electrolysis of potassium carbonate in light water, nuclei of H and ^{39}K pile up at the Ni cathode: a ^{40}Ca production is observed.

Shortly after the proton capture, the electron of miniatom could be captured by the excited nucleus, as modified by the preceding absorption. This second part of the process (electronic capture by the intermediate nucleus) would be generally endoergic, but it can came true by utilizing the left over energy from the previous reaction.

The final nucleus, after the twofold capture (miniatom capture), is characterized by (Z,A+1) numbers, as if a neutron were absorbed with (n,γ) reaction, but the our (pe, γ) process is quite different, and the neutron cross-sections don't are valid.

The resultant energy of twofold capture (pe,γ) is positive, but it is less than gamma energy of neutron capture (n,γ) ; indeed now the energy deficit of the proton-electron pair must be balanced.

Deuterium miniatom capture

The miniatoms hypothesis can be applied to the deuteron-electron reaction; in this case the electron capture is still more endoergic (Q≅ -3.1 MeV):

$$(1') \qquad d + e \Rightarrow n + n_{virt} + \nu .$$

To an initial proposition of Hagelstein[20] it was very easy to confute[21] that, also discounting the very small value of the probability of this electron capture, the virtual neutrons are "of shell" by a few MeV (so their range cannot be greater than a few tens of Fermis).

If the deuterium miniatom encounters a nucleus of mass number A, the total reaction may be :

$$(2') \qquad d + e + {}^{A}N \Rightarrow {}^{A+1}N + n + \nu$$

$$(2'') \qquad d + e + {}^{A}N \Rightarrow {}^{A+2}N + \nu$$

We remind the transition from ^{39}K to ^{41}K observed by Ohmori[22]. After the deuteron capture (that forms ^{41}Ca) the electron capture happens also spontaneously, being the mass balance (lightly) positive. This means the transition towards ^{41}K either happens at the miniatom arrival or will follow by orbital capture (when the nucleus will be in the fundamental state , with half-life of $2\cdot10^5$ y).

The double event "miniatom formation" and "compound nucleus formation " could justify the essential features of the Kamada experiment[23] where, instead of the (n,γ) reaction, it could occur a reaction of the (n,α) type with Q>0.78 MeV with nuclides present (also in small quantity) in Al or in CR-39. The random direction of the charged particles suggests that the neutron source was different from the narrow zone of the electrons incidence.

If the alone deuteron is captured, the (2') is replaced by :

$$(2''') \qquad d + e + {}^{A}N \Rightarrow {}^{A+2}N_{Z+1} + e + \nu \ .$$

An example : Vysotskii[24], with biologic cultures in heavy water, observed the d+^{55}Mn=^{57}Fe reaction, with rate of 10^{10} nuclei/s.

Muonic and Widom miniatoms

In past time the muonic miniatoms were studied, in which the orbital electron was replaced by a muon. Being its mass 200 times the electron mass, the muonic atom has a radius 200 times less than normal hydrogen atom. The consequent increase of the tunnel effect probability cannot have a practical utilization being too short (about a microsecond) the muon life.

According to Widom[25], the electron mass in condensed matter can be modified by local electromagnetic field fluctuations; the mass growth in the theory appears in a classic treatise on quantum electrodynamics[26]. The collective motions of the surface protons produce suitable oscillating electric fields which renormalize the electron self energy. In palladium the electron mass enhancement is 20.6, decidedly above the required minimum value of 2.531 for the (p+lepton) reaction.

Surface protons can capture a heavy electron producing an ultra low momentum neutron plus a neutrino , as in (1). This production can induce chains of nuclear reactions in neighboring condensed matter, according to the results of Iwamura[27]

One seeks to have nearly pure hydrogen isotopes as an easy support of the required coherent collective oscillations. However the transmutations could alter the initial purity.

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