Nuclear Instruments and Methods in Physics Research B xxx (2015) xxx–xxx

Contents lists available at ScienceDirect

Nuclear Instruments and Methods in Physics Research B

journal homepage: www.elsevier.com/locate/nimb

Cold nuclear fusion

E.N. Tsyganov [a,*], M.D. Bavizhev [b], M.G. Buryakov [c], S.B. Dabagov [d], V.M. Golovatyuk [c], S.P. Lobastov [c]

[a] Cold Fusion Power, International, USA
[b] LLC "Radium", Moscow, Russian Federation
[c] Joint Institute for Nuclear Research (JINR), Dubna, Russian Federation
[d] P.N. Lebedev Physical Institute of the Russian Academy of Sciences, National Research Nuclear University «MEPhI», Moscow, Russian Federation

ARTICLE INFO

Article history:
Received 2 December 2014
Received in revised form 19 January 2015
Accepted 20 January 2015
Available online xxxx

Keyword:
Cold fusion
Low Energy Nuclear Reaction (LENR)
DD fusion in metals
Crystal assisted nuclear reaction
Hydrogen orbitals

ABSTRACT

If target deuterium atoms were implanted in a metal crystal in accelerator experiments, a sharp increase in the probability of DD-fusion reaction was clearly observed when compared with the reaction's theoretical value. The electronic screening potential, which for a collision of free deuterium atoms is about 27 eV, reached 300–700 eV in the case of the DD-fusion in metallic crystals. These data leads to the conclusion that a ban must exist for deuterium atoms to be in the ground state *1s* in a niche filled with free conduction electrons. At the same time, the state *2p* whose energy level is only 10 eV above that of state *1s* is allowed in these conditions. With anisotropy of *2p*, *3p* or above orbitals, their spatial positions are strictly determined in the lattice coordinate system. When filling out the same potential niches with two deuterium atoms in the states *2p*, *3p* or higher, the nuclei of these atoms can be permanently positioned without creating much Coulomb repulsion at a very short distance from each other. In this case, the transparency of the potential barrier increases dramatically compared to the ground state *1s* for these atoms. The probability of the deuterium nuclei penetrating the Coulomb barrier by zero quantum vibration of the DD-system also increases dramatically. The so-called cold nuclear DD-fusion for a number of years was registered in many experiments, however, was still rejected by mainstream science for allegedly having no consistent scientific explanation. Finally, it received the validation. Below, we outline the concept of this explanation and give the necessary calculations. This paper also considers the further destiny of the formed intermediate state of $^4He^*$.

1. Introduction

During 21–27 July 2013, the University of Missouri, Columbia, hosted the 18th International Conference on Cold Fusion (ICCF-18). This conference demonstrated increasing scientific interest in this natural phenomenon, first noted in the work of Fleischmann and Pons [1] in 1989. The Conference presented new experimental data on cold fusion while possible theoretical interpretations of these results were given. The next conference ICCF-19 will be held in April 2015 in Padua, Italy. A breakthrough in the recognition of cold fusion can occur just after the Conference.

As noted above, in numerous experiments on low-energy accelerators [2–14], it has been observed for some time that an increase in the probability of DD fusion reactions occurs, as compared to their calculated value, when a target deuterium atom is implanted in metallic crystals. This effect is not observed in cases where the target deuterium atom is free or implanted in semiconductors, insulator-crystals, or amorphous bodies. The so-called electronic screening potential U_e, which, in the case of the collision of free deuterium atoms, is about 27 eV [15] and substantially characterizes the size of unexcited deuterium atom, is equal to about 300–700 eV in the case of DD-fusion in a metal crystal environment. Essentially, this means that in a conducting crystal media, deuterium atoms can converge without Coulomb repulsion at a distance of 1/10–1/20 of the nominal dimensions of these atoms. The development of this approach was set out in our papers [16–20].

2. The orbitals of the hydrogen atom

Fig. 1, left, graphically depicts the orbital of a hydrogen atom in a state of *1s*. On the right side of the same figure, the representation of the orbital of the first excited state of the hydrogen atom *2p* is shown. This figure is taken from the Encyclopedia Britannica of 2013. The excitation energy of the atom in the *2p* state is about 10 eV. The extensive experimental data on the large electron screening potential (300–700 eV) in DD-fusion—obtained from the low-energy accelerators when the target deuterium atoms

* Corresponding author.
E-mail address: edward.tsyganov@coldfusion-power.com (E.N. Tsyganov).

http://dx.doi.org/10.1016/j.nimb.2015.01.039
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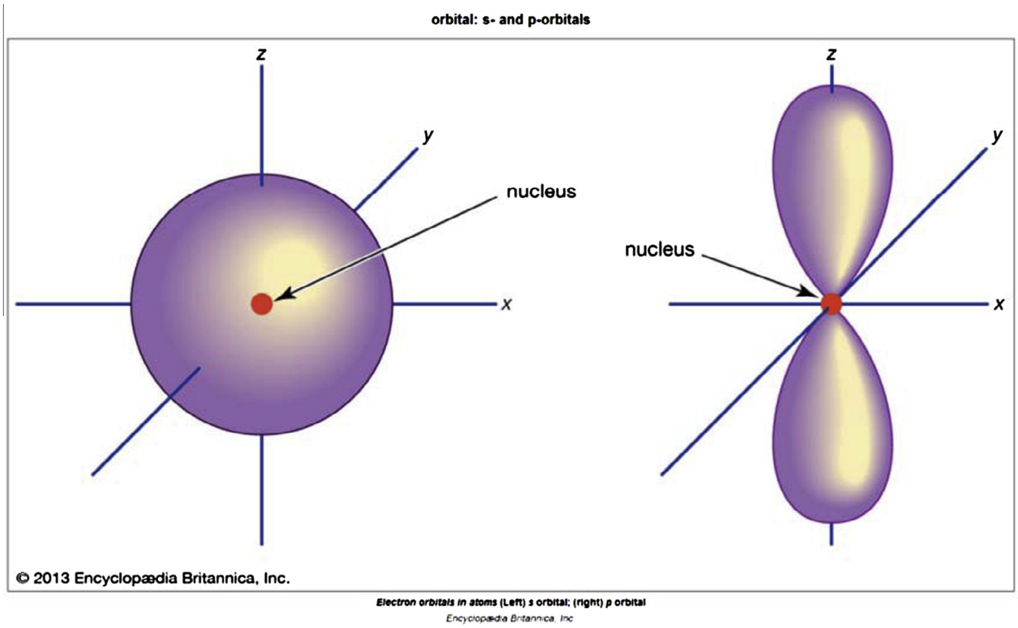

Fig. 1. Hydrogen atom orbitals *1s* (left) and *2p* (right). Picture taken from the Encyclopedia Britannica, 2013. Presented contours include 95% of the possible positions of the electron.

are implanted in conducting crystals—indicate that there is a ban imposed on deuterium atoms in the state of *1s* in the crystal by a cloud of free conduction electrons. At the same time, the state of the *2p*, *3p* and higher in this environment are allowed.

Fig. 2 gives graphical representation of the first excited orbitals of the hydrogen atom and the corresponding energy levels of the electron. Fig. 3 presents the orbitals of the hydrogen atom (the solution of the Schrödinger equation) in Winter's work [21].

Given the fact that the spatial orientation of the *2p*, *3p* state or higher in the structure of the crystal cell is strictly deterministic, two deuterium nuclei can be placed in a potential niche of two crystallographic deuterium atoms in the state *2p*, *3p* or higher at a very close distance. The cold fusion process begins when all octahedral crystallographic vacancies have been filled once with deuterium nuclei. This is illustrated in Fig. 4, taken from [23]. The so-called "zero" quantum vibrations between the nuclei of deuterium atoms cause a sharp increase in the reaction probability of DD-fusion, followed by further filling of the octahedral niches. This effect is also illustrated in Fig. 5, which shows success of registration of the additional heat created in about 40 experiments on cold fusion, depending on the degree of concentration of deuterium atoms in Palladium crystals.

The color scale on the left of Fig. 6 in the plane $Z = 0$ shows the distribution of electric potentials in the crystal cells of Platinum; the scale of the coordinates X and Y are given in nanometers. At the center of Fig. 6, in the plane $Z = 0$, is shown the arrangement of the deuterium atoms in the *2p* state in the crystal cells of Platinum. The spatial arrangement of the deuterium atoms in the

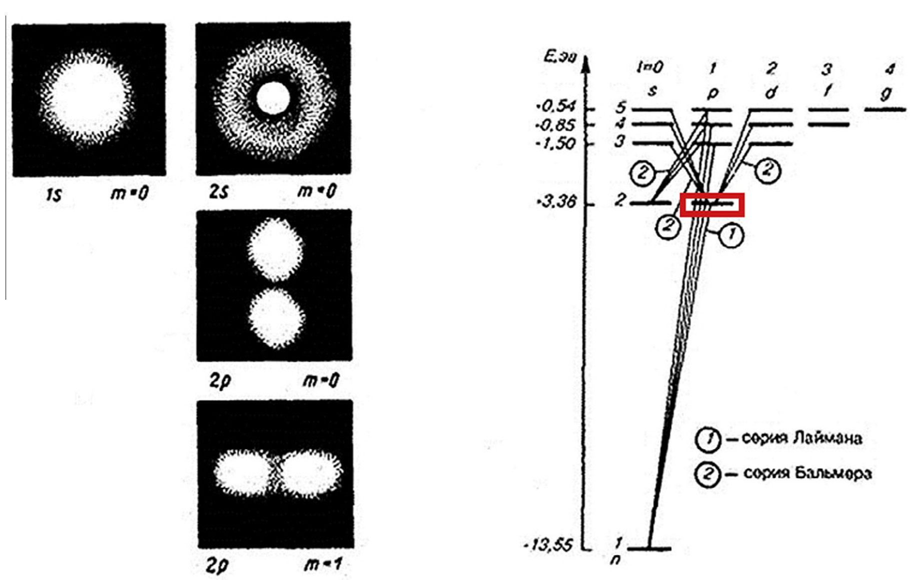

Fig. 2. Graphical representation of the first excited orbitals of the hydrogen atom and the corresponding energy levels of the electron.