To: Doctor of Physical and Mathematical Sciences Yu.V. Martynenko
From: Edward N. Tsyganov

Dear Yuri Vladimirovich!

Thank you for your review on behalf of the Kurchatov Institute of my appeal to the President of the Russian Federation, V.V. Putin, on the issue of so-called cold fusion. Your review is quite valuable because it ends the complete silence imposed on our country by supporters of traditional fusion research in nuclear physics on the so-called cold fusion. Let us assume that the debate between the supporters of the "cold" and "hot" nuclear fusion from that moment has begun. It will contribute to the further development of science.

It is well known that mankind now has come to a stage of development where the struggle for energy resources is becoming especially important. All known sources of energy in the near future will not be enough for our needs. Chemical energy, moreover, is limited by the so-called greenhouse effect. Nuclear energy based on the use of fissile materials is also not a long-term solution, because the stock of this material is quite limited. In addition, the radioactive waste produced from these sources will remain hazardous for thousands of years.

Initial optimistic expectations for transition to the controlled thermonuclear fusion process have not yet materialized. The technical difficulties of obtaining sustainable superhot plasma as well as the damaging effects of the enormous neutron flux arising from the majority of thermonuclear reactions have pushed this task toward the more distant and uncertain future. You are, unlike anyone else, well-aware of all the technical difficulties of this task.

On the other hand, the belief that the problem of controlled nuclear fusion can be solved with the use of "cold" nuclear fusion has recently arisen. The probability of fusion processes greatly depends on the physical state of the matter in which the reactive atoms are placed in has been experimentally shown. The distance of the approach of two deuterium nuclei, placed in a single niche of crystalline metals, could be by an order of smaller magnitude than what takes place in a hydrogen molecule. Coulomb barrier permeability in such a process of DD fusion very much (by the 50-60 orders of magnitude) increased compared to the permeability barrier of the free molecule of deuterium.

Calorimetric experiments on the so-called cold fusion were initially rejected in 1989 as non-scientific. However, they continued and have been upgraded in the last 25 years. Currently, the situation in nuclear physics has come to a stage where experiments on cold fusion simply can no longer be stubbornly ignored.

In addition to the calorimetric measurements, multiple experiments were conducted in Japan and Europe from 1996–2009 to study the process of nuclear fusion on accelerators at low energies. These experiments showed that the reaction probability of so-called hot fusion in the case where the target particle was implanted into the conductive crystal increased dramatically compared to the probability of the collision of the reaction with free atoms. The influence of electron screening for the collision of free deuterium atoms is equivalent to an "additional energy" of 27 eV. If the target deuterium atom in this reaction is implanted in the conductive crystal and the fusion process goes on in these conditions, then this "additional energy" equals to 300–700 eV.

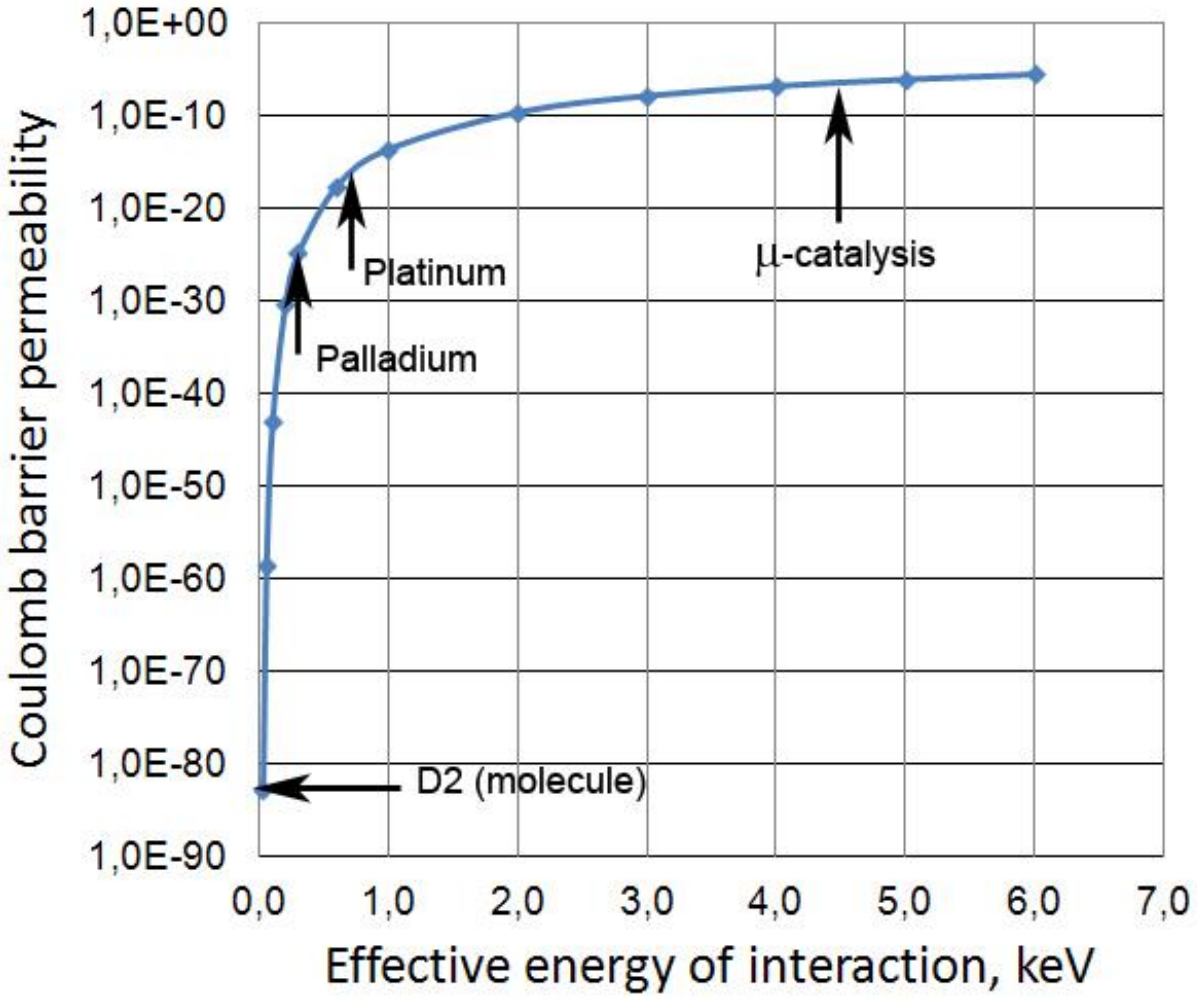
In the context of conducting crystal, the reaction of “hot” DD fusion at low energies of the incident deuteron goes on as if the dimensions of the deuterium atoms in a collision are 1/10–1/20 of their nominal sizes. It is necessary to make two assumptions to explain these experimental results that were repeatedly proved:

1. In the context of DD reactions in a conducting crystal, the target atoms of deuterium exist predominantly in the excited state, such as the *2p*-state due to the effect of the clouds of free electrons. In the case of the “hot” fusion, this fact also holds for the slow-moving incident deuterium atom.

2. The orientation of these non-spherical excited hydrogen atoms in the conductive crystal is no longer arbitrary. This orientation is defined by a cloud of free electrons in the crystal cell and determined by the configuration of the crystal lattice of the conductor. The absolute crystalline *ordnung*, the strict “crystalline order,” takes place.

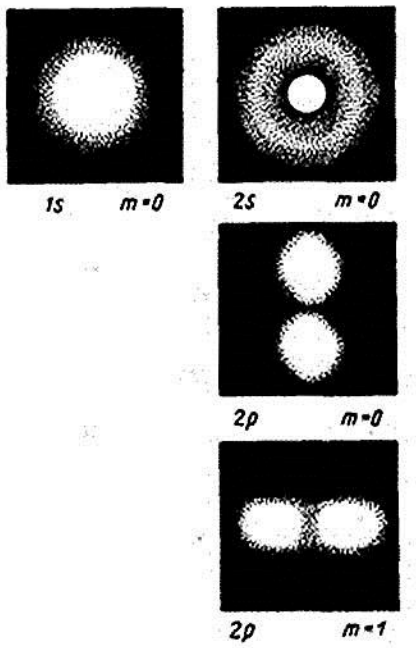
As I understand it, dear Yuri Vladimirovich, the first condition in your response to my review is not questioned. However, the presence of the second condition usually eludes readers unfamiliar with the specifics of the crystal, and you are no exception.

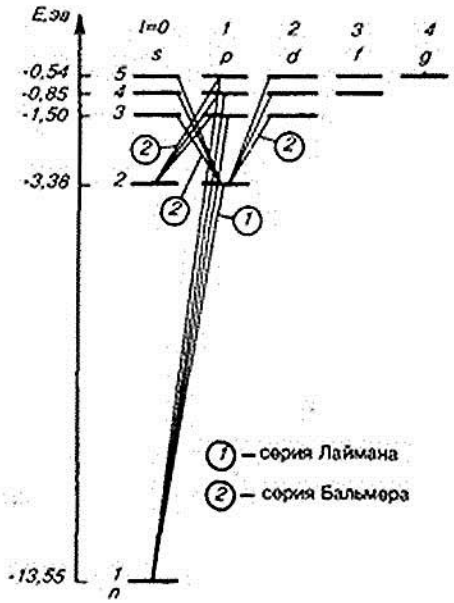
In the case of cold fusion deuterium, impurity atoms in metallic crystals of palladium or platinum are placed in octahedral, the deepest niches of these crystals. Until not all of these niches are filled, that is, until the ratio of Pd: D ≤ 1, the distance between neighboring atoms of deuterium is still high in the order of the interatomic distances in the crystal. However, when the ratio of Pd: D greater than one, in some octahedral niches, more than one deuterium atom happens to occur. In this case, the deuterium nuclei that are, for example, a *2p*–state in the same niche of a heavy octahedral conductive crystal happen to be pulled together with another with a distance equal to 1/10–1/20 of its nominal dimensions. In this case, as we have heard recently, “the process has begun.” It is appropriate to show here the absolutely uncompromising quantum-mechanical calculation of DD Coulomb barrier transparency for this case:



In this graph, the horizontal axis represents the so-called effective energy of DD interactions that for the case of cold fusion effectively equals to the electronic screening potential, and the vertical axis represents the permeability of the Coulomb barrier. When compared to the free molecule of deuterium, the permeability of the Coulomb barrier in experiments on cold fusion increases by ≈ 60 (!) orders of magnitude. This only graph is enough to recognize the reality of the cold-fusion process. It seems to us that our work over the past two years has convincingly shown this.

The following figure schematically shows plots of the electron density in the hydrogen atom for the *1s*, *2s*, and *2p* states. The required excitation of the hydrogen atom to translate it into *2p* state is only about 10 eV. This process namely shows the cold fusion reaction, bringing together the nuclei of deuterium atoms caught in a single potential niche.





Our consideration of this matter's situation is detailed on the following webpage:

http://www.coldfusion-power.com/

Some of my comments to your review are given below in red:

Review

On the work of E.N. Tsyganov "Cold nuclear fusion"

You have misspelled my first name in Russian version.

The author gives an overview of works on the following cold fusion reactions:

D+D → n+^{3}He+3,268 MeV.

D+T → n+^{4}He+17,589 MeV

I did not consider at all these reactions in my papers. Is it really my work that you are referring to?

Experiments on medium-energy ion accelerators have shown the cross-section of DD-reaction on nuclei located in metals (Pt, Pd, etc.), indeed for 1 - 2 orders of magnitude larger than for the nuclei of the free atoms.

And why is this happening?

However, the explanation of this fact, given by the author, is not acceptable. The electron of the hydrogen atom (D, T), located in the lattice of the solid body, is really in a different state. Moreover, the energy levels of the atom, "compressed" atoms of the solid, rose. Recall (L.D. Landau and E.M. Lifshitz, "Quantum Mechanics") the position of the levels in the potential well-defined parameter Ua^2, where U –

depth of the well, and a – well width, which decreases with "compression" of the hydrogen atom. The smaller the Ua^2, the higher the levels and the greater the distance to the core of the electron orbit. *(You are apparently talking about the **maximum** distance from the electron orbit to the nucleus.)* In some cases, the hydrogen in metals has no single level [B.A. Trubnikov, Y.N. Yavlinsky, JETP, 1965, v. 48, p. 1618]. In this connection the known fact may be recalled that the rising level of the atom as it approaches the surface of the solid is a result of the potential of the surface atoms. Therefore, we can not say that the hydrogen atoms in metals shield electrons at shorter distances. This also applies to the minimum distance of the electron in the *p*-state.

I do not quite understand what that phrase means. The figure above shows exactly the scheme of this 2p state. Accelerator experiments show that in the DD fusion process in conducting crystals, two deuterium atoms approach each other without repulsion up to distances of 1/10 – 1/20 of nominal deuterium size.

Note also that in a solid state, no forces are capable of pulling together hydrogen atoms at a distance of the potential 300 eV or more, since the force constants (elastic moduli) in solids do not exceed 10 eV/atom. Therefore, it is not possible to transfer the results obtained on the accelerators to conditions of hydrogen dissolved in metals.

Your arguments show that you do not admit that the orientation of an atom in excited 2p-state in the crystal lattice can be spatially determined. After that, there is no need of any additional forces to be applied to atoms to approach each other in a single crystalline niche.

As far as I know, the reaction of cold nuclear fusion of hydrogen isotopes dissolved in metals indeed does come with a probability greater than one would expect, but still its rate is negligible enough to rule out talking about cold fusion as an energy source.

To verify the contrary, I advise you to conduct by yourself the Coulomb barrier permeability calculations following Assenbaum, etc., using the electron screening potentials obtained in the experiments.

At the same time, studies in this direction are interesting and can be useful, for example, for hydrogen energetics.

Thank you for the term! Go forward to cold hydrogen nuclear power!

Doctor of Physical and Mathematical Sciences  Yu.V. Martynenko