ICCF-19

COLD NUCLEAR FUSION

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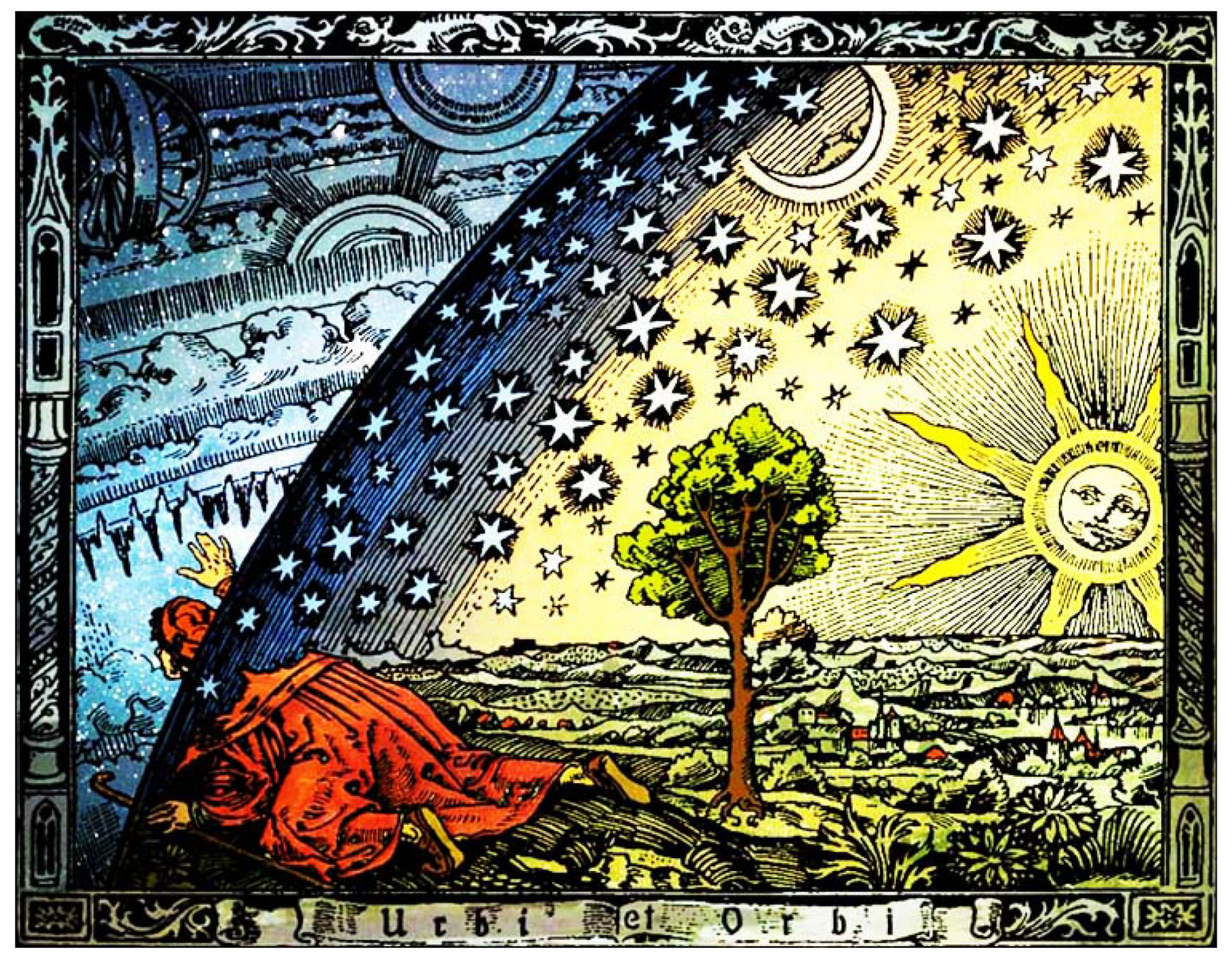
Cold nuclear fusion. *Look beyond the horizon ...*



Flammarion, 1888, based on the 16th century vision

1965 Nobel Price winners in Physics for QED

Sin-Itiro Tomonaga

Richard Feynman

Julian Schwinger

Currently, humanity has come to a stage of development when struggle for energy resources is becoming especially important. All known sources of energy together will not be able to provide for our demand in the near future. Chemical energy is additionally limited by the so-called greenhouse effect.

Nuclear energy that based on the use of fissile materials is not the long-term solution to the problem, because stocks of these materials are limited. In addition, the required safe preservation of the radioactive waste for about 10,000 years is a serious problem.

Initial optimistic expectations of a transition to the controlled thermonuclear fusion process not materialized yet. Technical difficulties of obtaining viable and stable super-hot plasma and damaging effects of the enormous neutron flux arising as a result of thermonuclear reactions are pushing this development to the more distant and uncertain future.

The term “cold fusion” describes a number of processes at relatively low temperature, leading to the generation of heat due to fusion of two nuclei.

Under normal conditions, such processes are prevented by the Coulomb barrier, which precludes the convergence of nuclei. For example, for a molecule of deuterium the probability to overcome the Coulomb barrier is close to 10^{-90}.

Cross-section of fusion in collision of two deuterium nuclei:

$$\sigma(E) = S(E)\, E^{-1} \exp(-2\pi\eta(E))$$
$$2\pi\eta = 31.41/E^{1/2}$$

Here, kinetic energy of the deuteron E is shown in the center of mass in keV. $S(E)$ — so called astrophysical factor, at low energies it can be assumed to be constant. The main energy dependence of the cold fusion cross-section is contained in the expression $\exp(-2\pi\eta(E))$ which determines the probability of penetration of the deuteron through the Coulomb barrier in a single collision. In the case of a collision of atoms, energy E must be replaced by $E_{eff} = E + U_e$. For unexcited hydrogen atoms $U_e = 27$ eV.

About 25 years ago Fleischmann and Pons performed experiments that demonstrated the possibility of “cold” DD fusion when nuclear reagents are implanted in metallic crystals.

Quickly (in about “40 days and nights”) rejected by most physicists as *irreproducible* and not having a consistent theoretical interpretation, these experiments, however, gradually began to give consistent experimental results.

Classic examples are the experiments made by Dr. McKubre and his colleagues at Stanford Research Institute, International. Results of these experiments demonstrated a reliable heat deposition of nonchemical origin, whereby the effect exceeded about 100 experimental errors.

History of cold fusion – the main participants

Martin Fleischmann (1927–2012) D + D in palladium
1989

Michael McKubre
D + D in palladium
1992–present

Yoshiaki Arata
D + D a palladium
(ZrO2) 1998–2008

Proof of concept of cold fusion suddenly came from experiments performed at accelerators

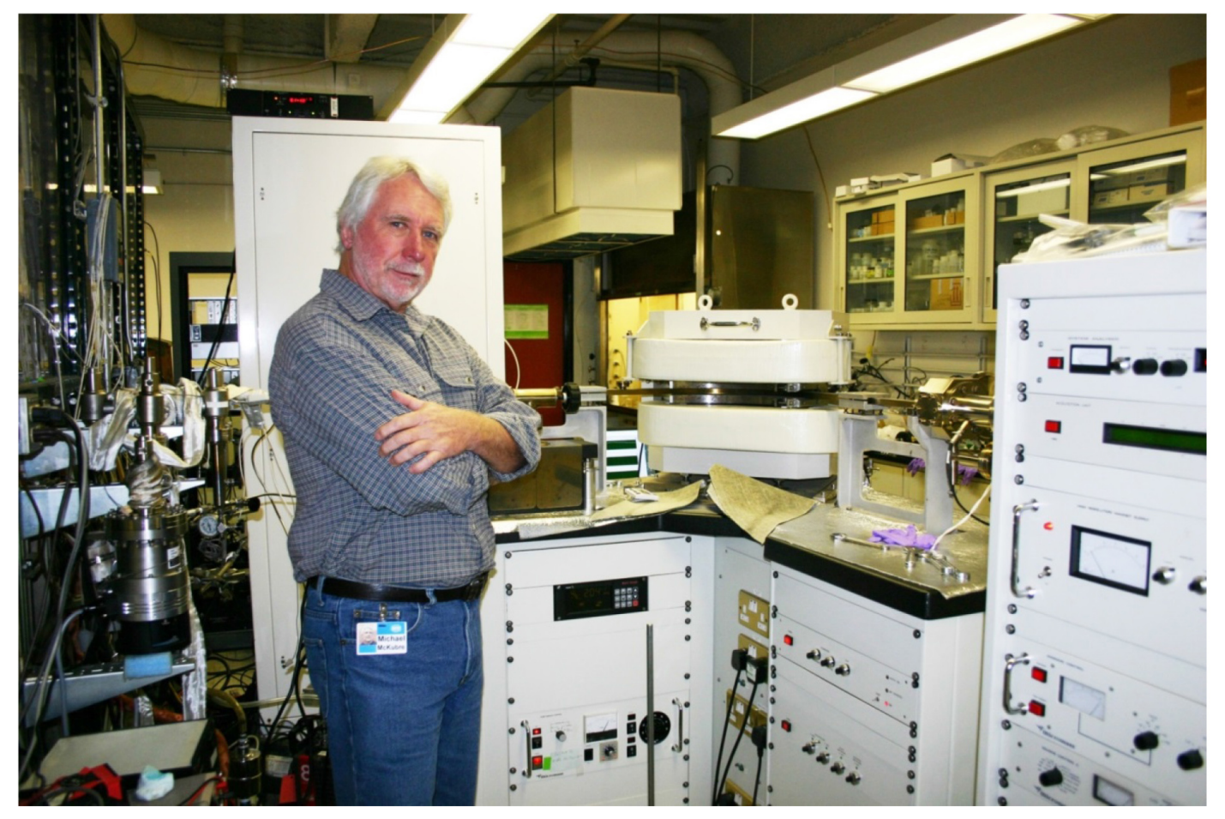
History of cold fusion “in vitro”

1.	Martin Fleischmann	1989–2012
2.	Michael McKubre	1992–today
3.	Yoshiaki Arata	1998–2008
4.	Hagelstein and Swartz (MIT)	1992–today

About 20–30 working groups in the US, Western Europe, Russia, Japan, and China.

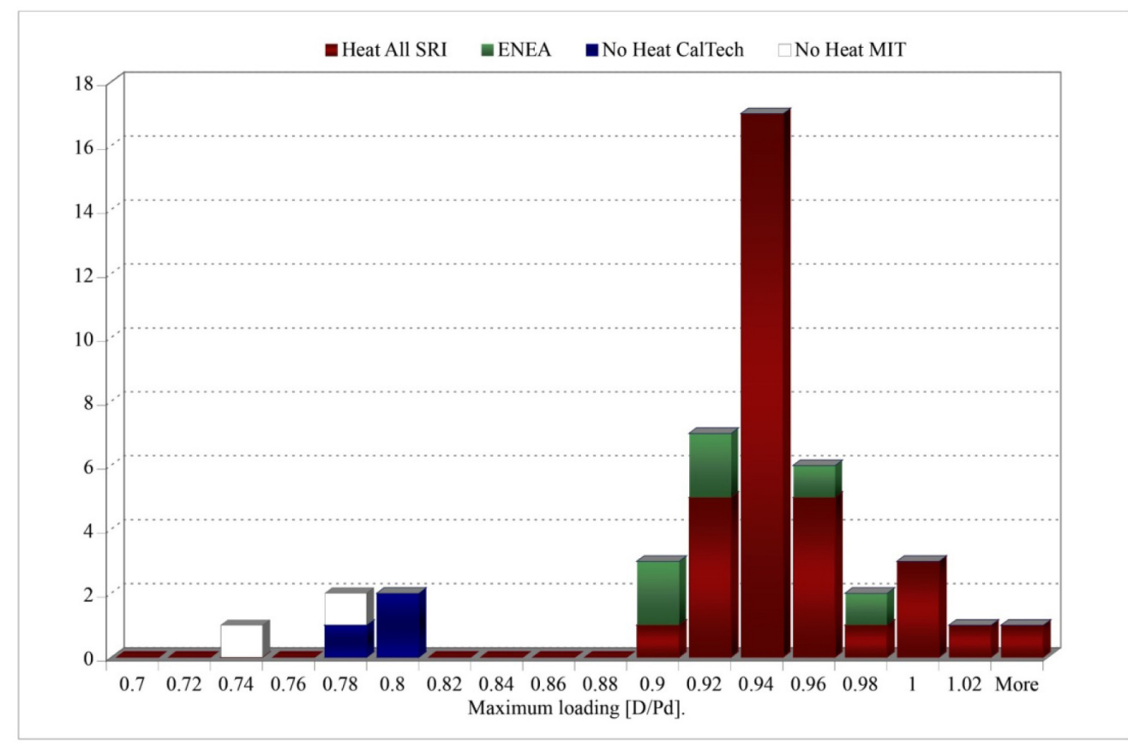
Recently, the first patents were issued for cold fusion (US, Europe)

Dr. McKubre in his laboratory.



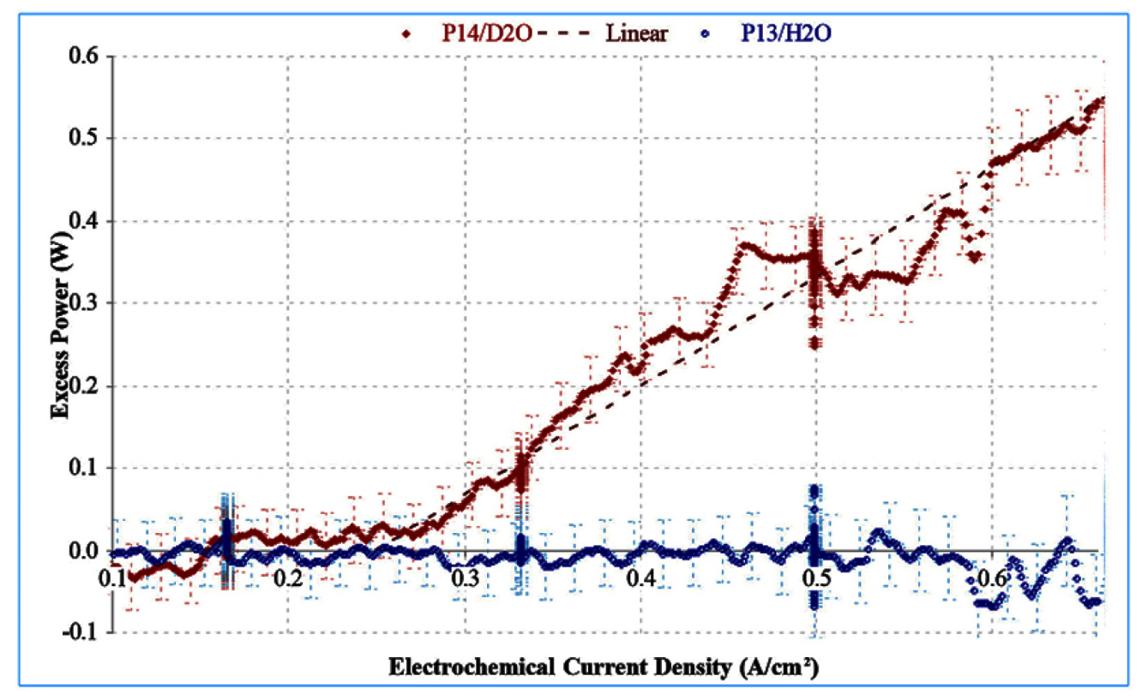
The success of the experiments depends on the concentration of deuterium.

“Achieve High Maximum D/Pd Ratio (Loading)”



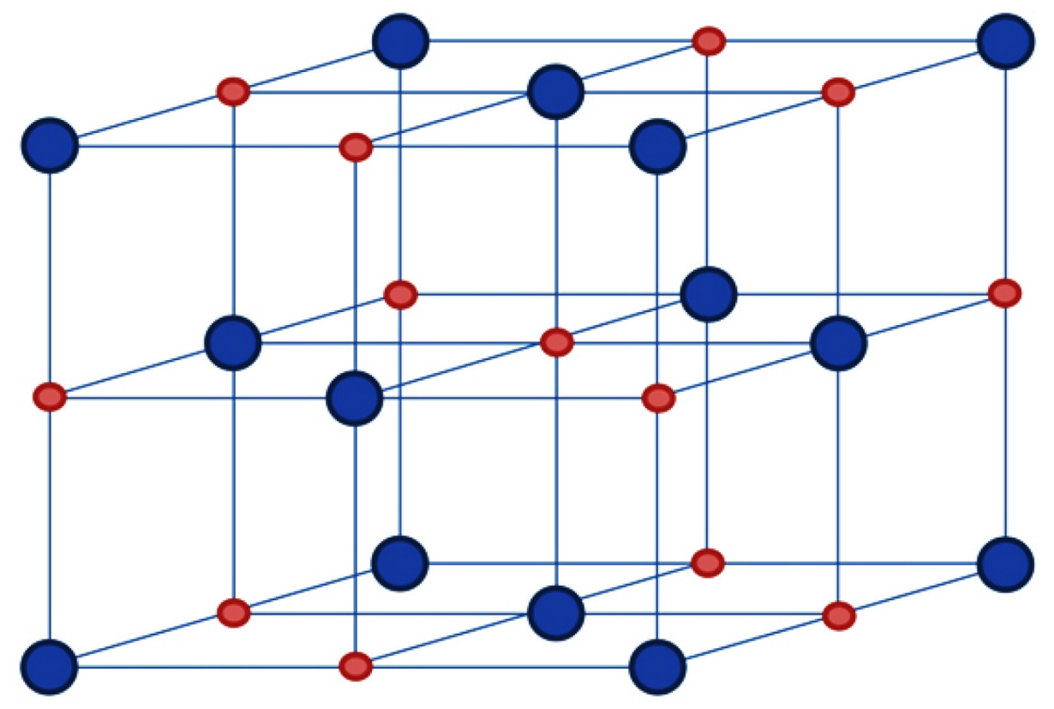
Michael C.H. McKubre, Francis L. Tanzella, and Vittorio Violante, Journal of Condensed Matter Nuclear Science, Volume 8, May 2012, p. 187

Excess power, depending on the value of the Electrochemical Current Density, in experiments of Dr. McKubre



Vittorio Violante, Bill Gates, 2014

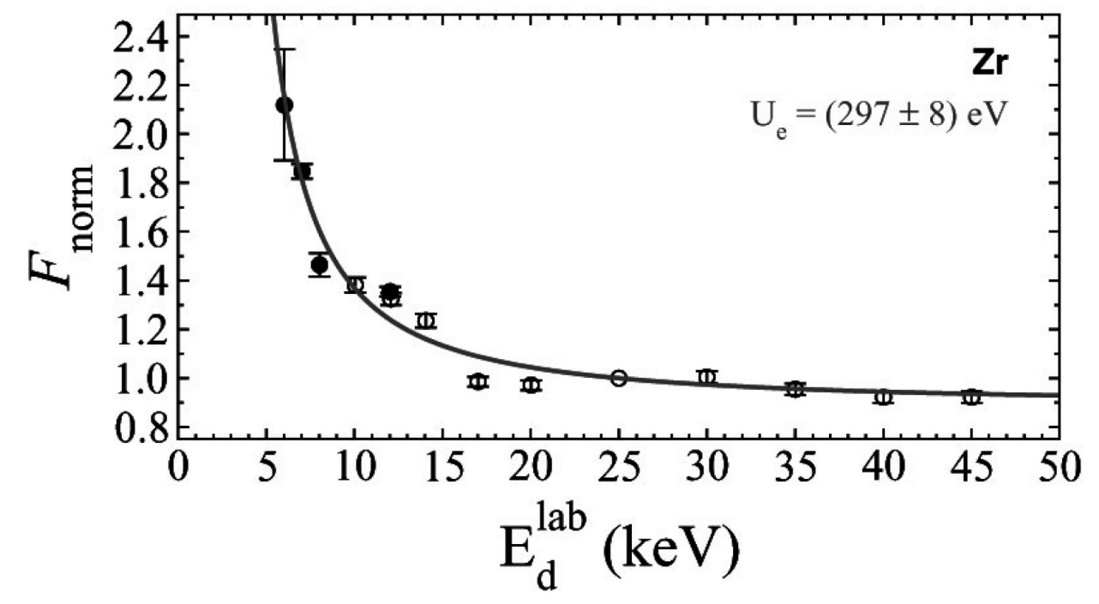
The fcc crystal structure. Small circles marked positions of octahedral (the deepest) niches



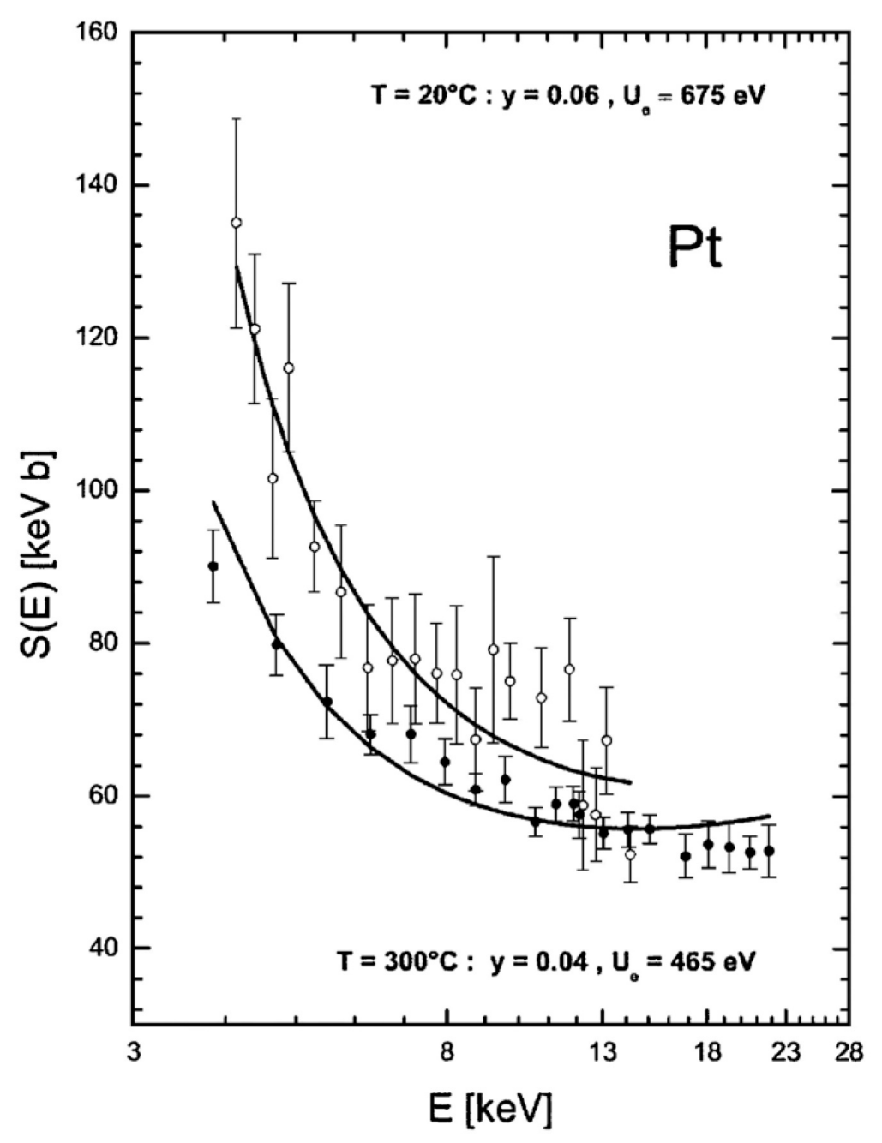
It should be noted that during irradiation of solid state with a beam of charged particles, *incident particle captures an electron from the solid body and moves like an atom*, if its velocity does not exceed the so-called Bohr velocity.

For deuterons this threshold energy is ~ 50 keV. This interesting observation was made in the paper: *Y.A. Baranov, Yu. Martynenko, S.O. Tsepelevich, Yu.N. Yavlinsky, “Inelastic sputtering of solids by ions”, Physics-Uspekhi, November 1988, Volume 156, no. 3, p. 477.*

Czerski, K. et al., (2008). Physical Review C., 78, 015803, (Berlin). Normalized astrophysical factor $S(E)$ for DD-fusion, when the target is implanted in zirconium. Screening potential is about 10 times greater than for the free atoms of deuterium.



Rolfs, C. et al. (2005). J. Phys. G: Nucl. Part. Phys., 31, 1141–1149, Gran Sasso. $S(E)$ for DD-fusion, targets are implanted in Platinum, U_e = 675 eV.



The main secret of cold fusion process —overcoming the Coulomb barrier — finally happened to be surprisingly simple. It was at first noticed by Prof. Bressani in 1998 at ICCF-7 conference on the basis of a series of Japanese accelerator experiments being performed since 1995.

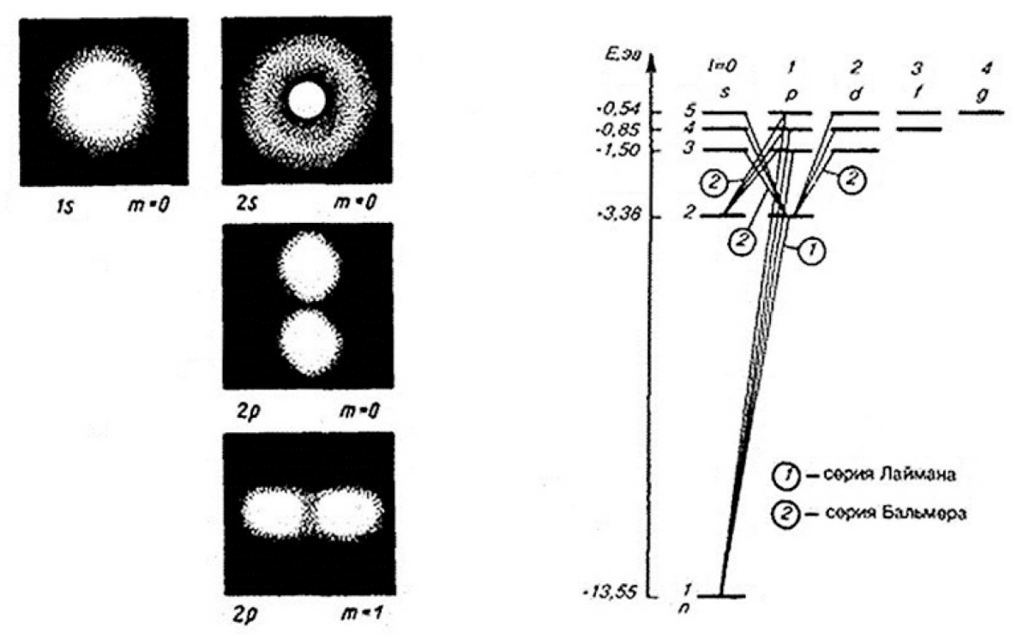
Unfortunately, the cold fusion community at that time did not follow the call of Prof. Bressani.

Target deuterium atoms implanted into metals *are no longer in a ground 1s-state.* The free electron cloud in a metal causes the electron of an implanted atom *to take up the excited p*-states. The magnitude of the screening potential of *300 eV* and higher in experiments on DD-fusion accelerator experiments indicates that the incident deuterium atoms in the conducting crystal during reaction are *also in p-states.*

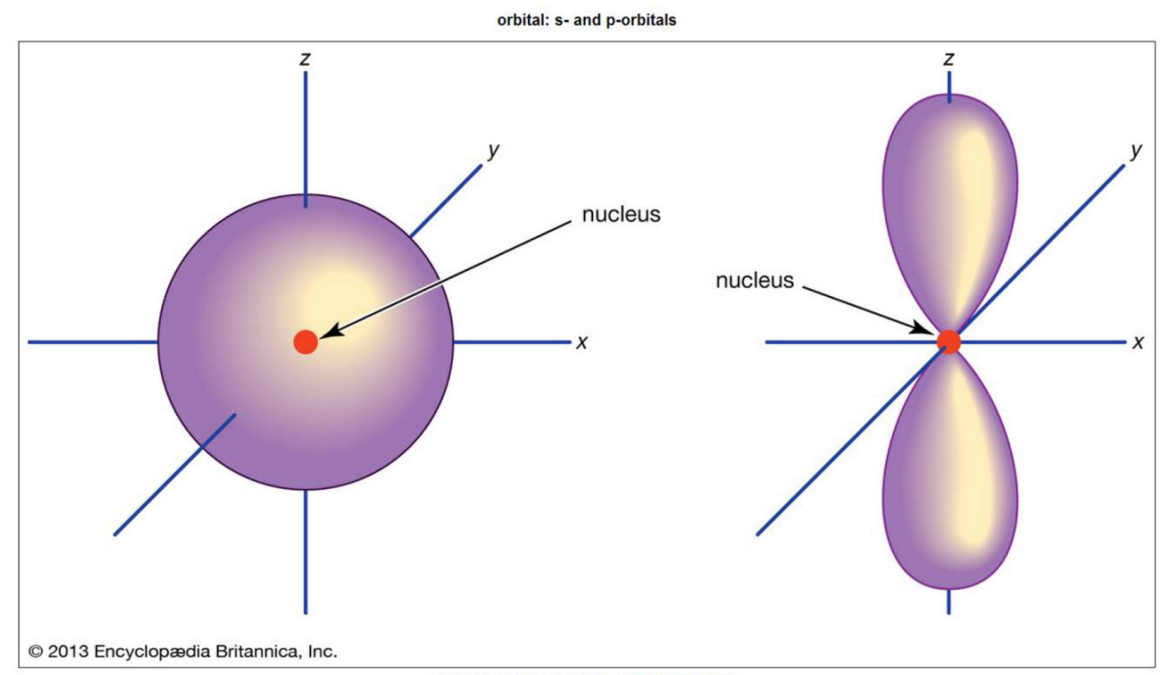
These processes allow the two deuterium nuclei to get close to each other without strong Coulomb repulsion in the potential niche of the crystal cell at a very close distance.

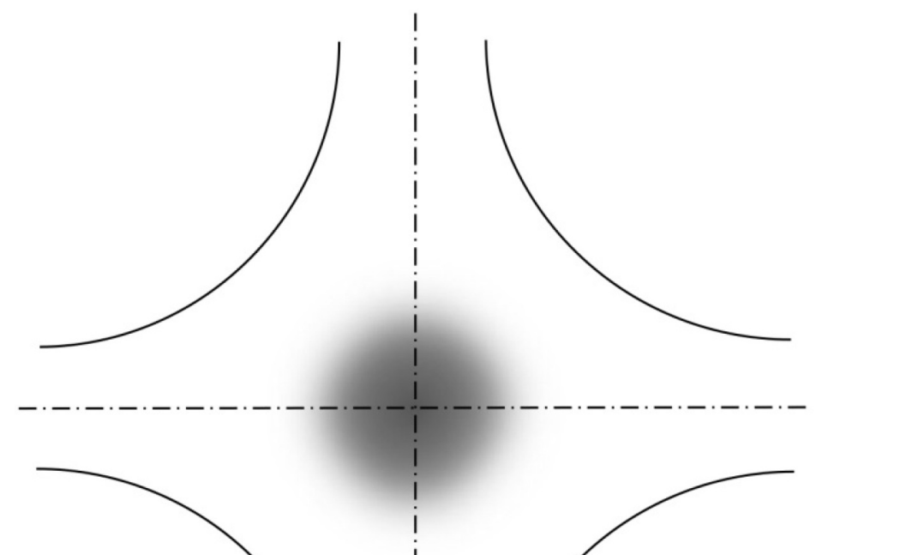
These accelerator experiments have shown that the magnitude of the electron screening potential of the impurity atoms in metallic crystals can reach *300 eV and even more.* This means that in the DD-reaction, occurring in the medium of the metal crystal, the implanted deuterium atoms and incoming deuterium atoms are excited and no longer spherical. They have more sophisticated *electronic orbitals, such as 2p, 3p*, etc. Target atoms are oriented in a crystal in a certain crystallographic manner. *In this case, the nuclei of two atoms can approach each other without Coulomb repulsion at the distances substantially less, than for a size of the unexcited atoms.*

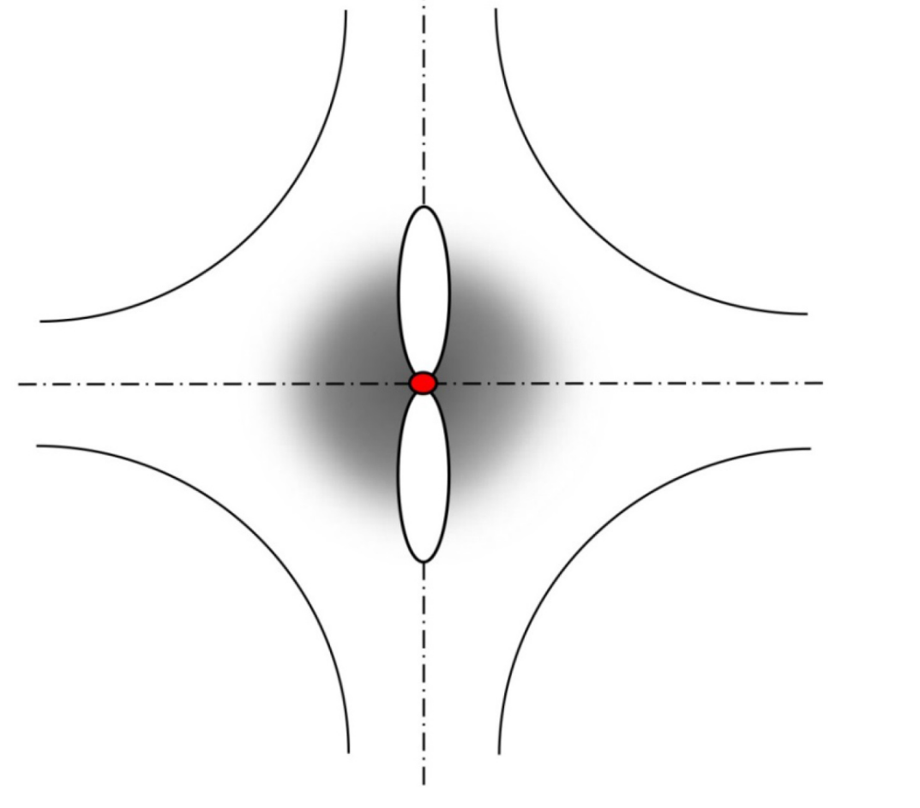
Rydberg mechanism for the hydrogen atom. Electron orbital in *2p*-state is no longer round.

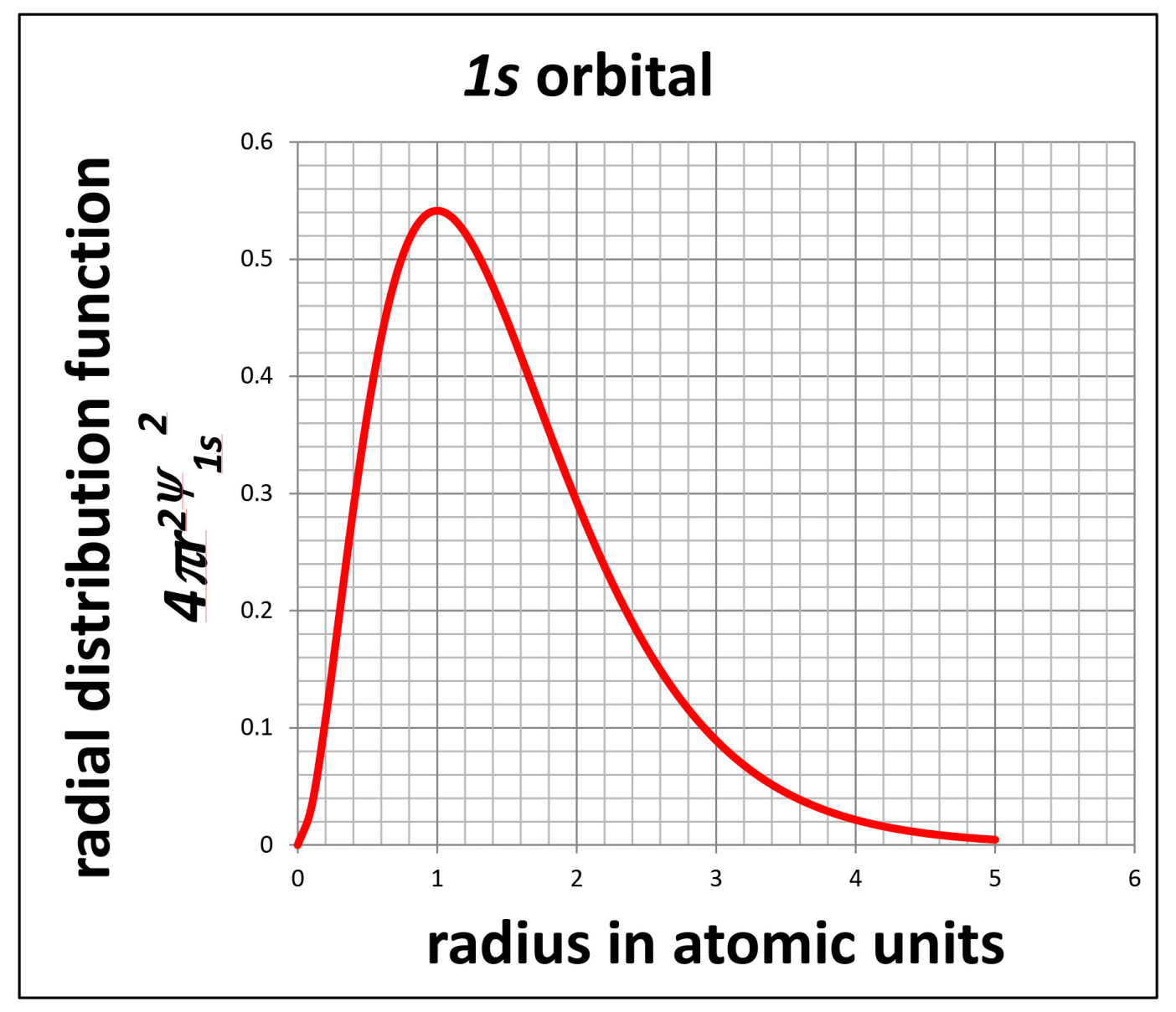


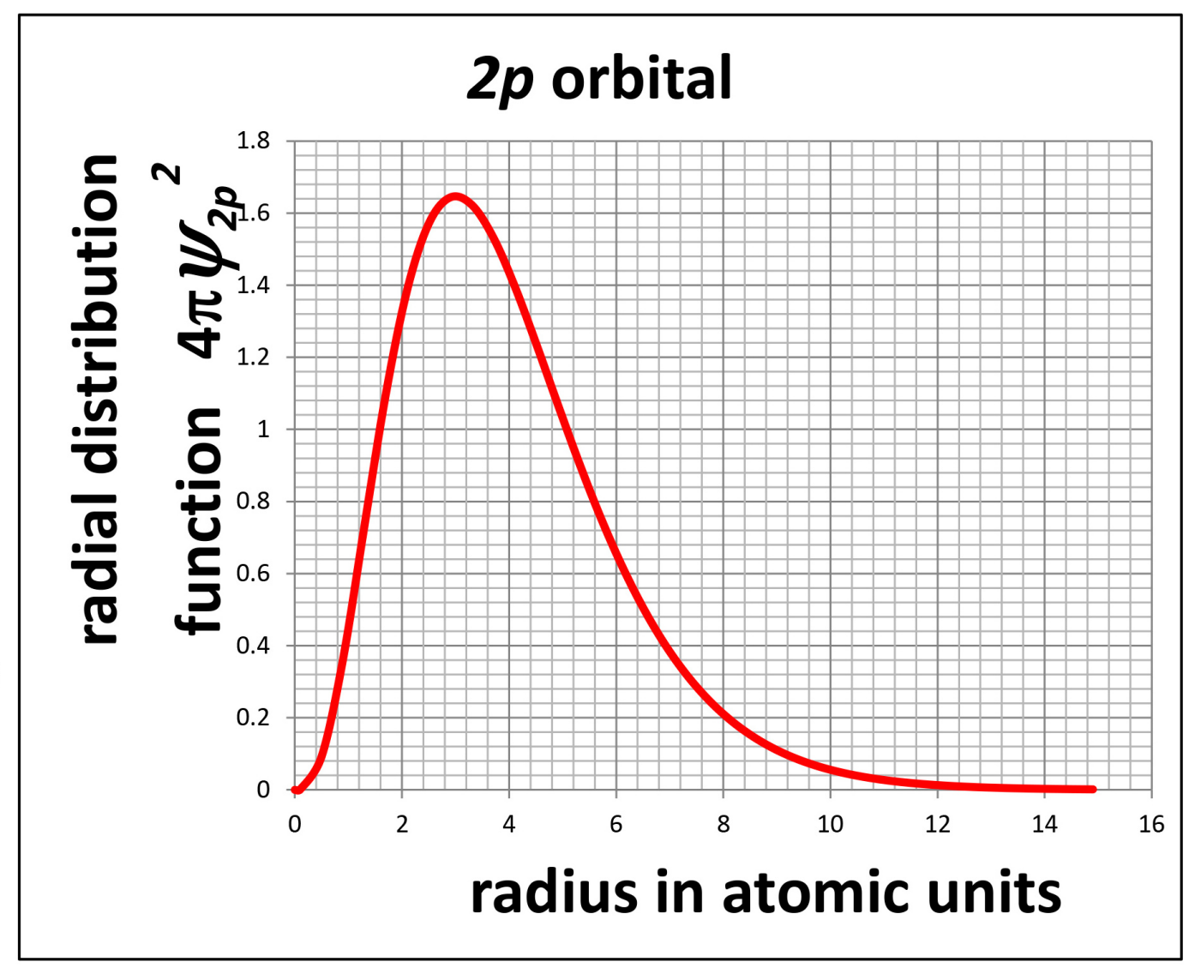
Orbitals of the Hydrogen atom, ©2013 Encyclopædia Britannica, Inc.



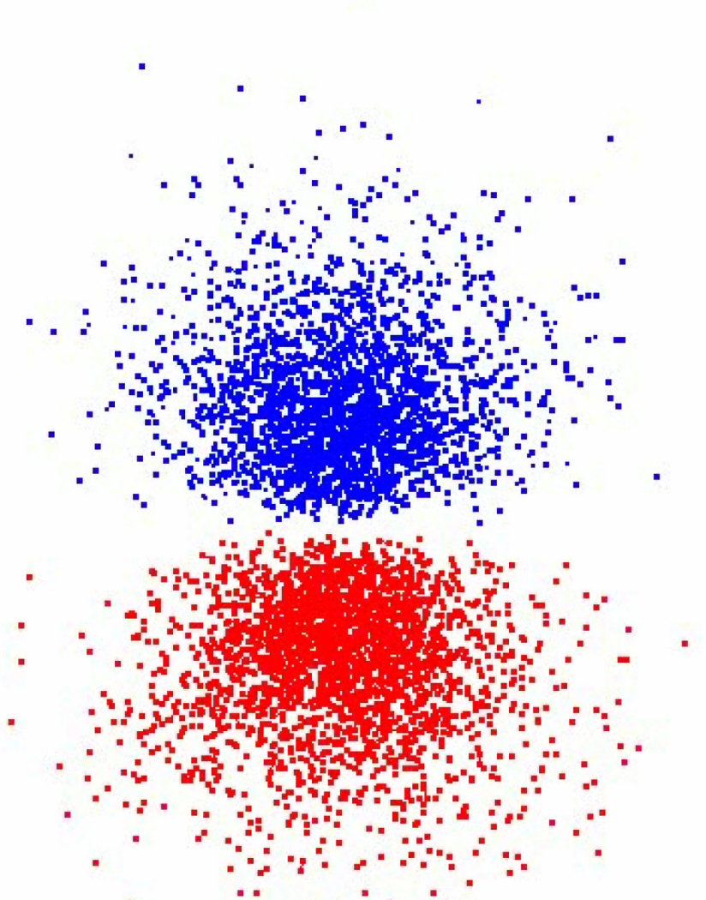




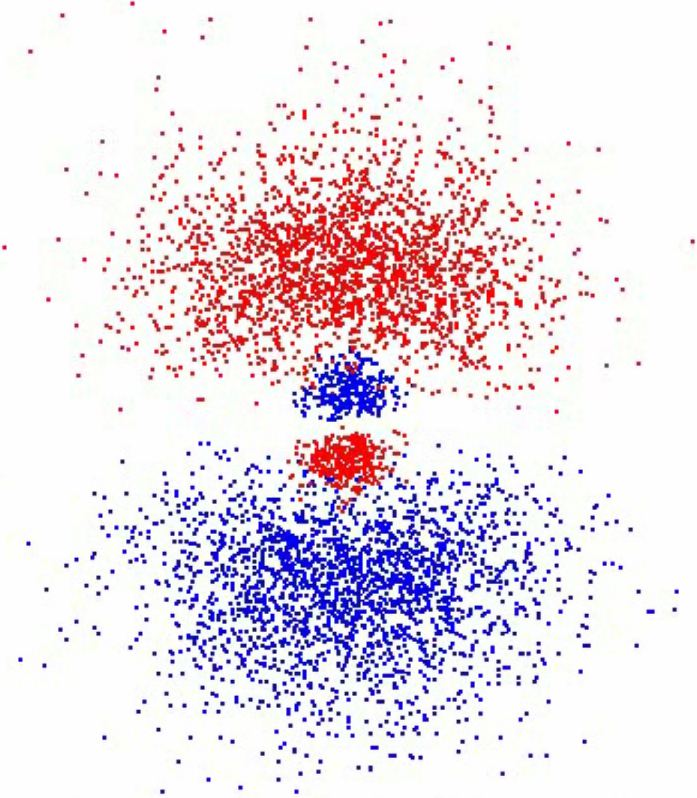




2p-state of Hydrogen atom by Dr. Winter



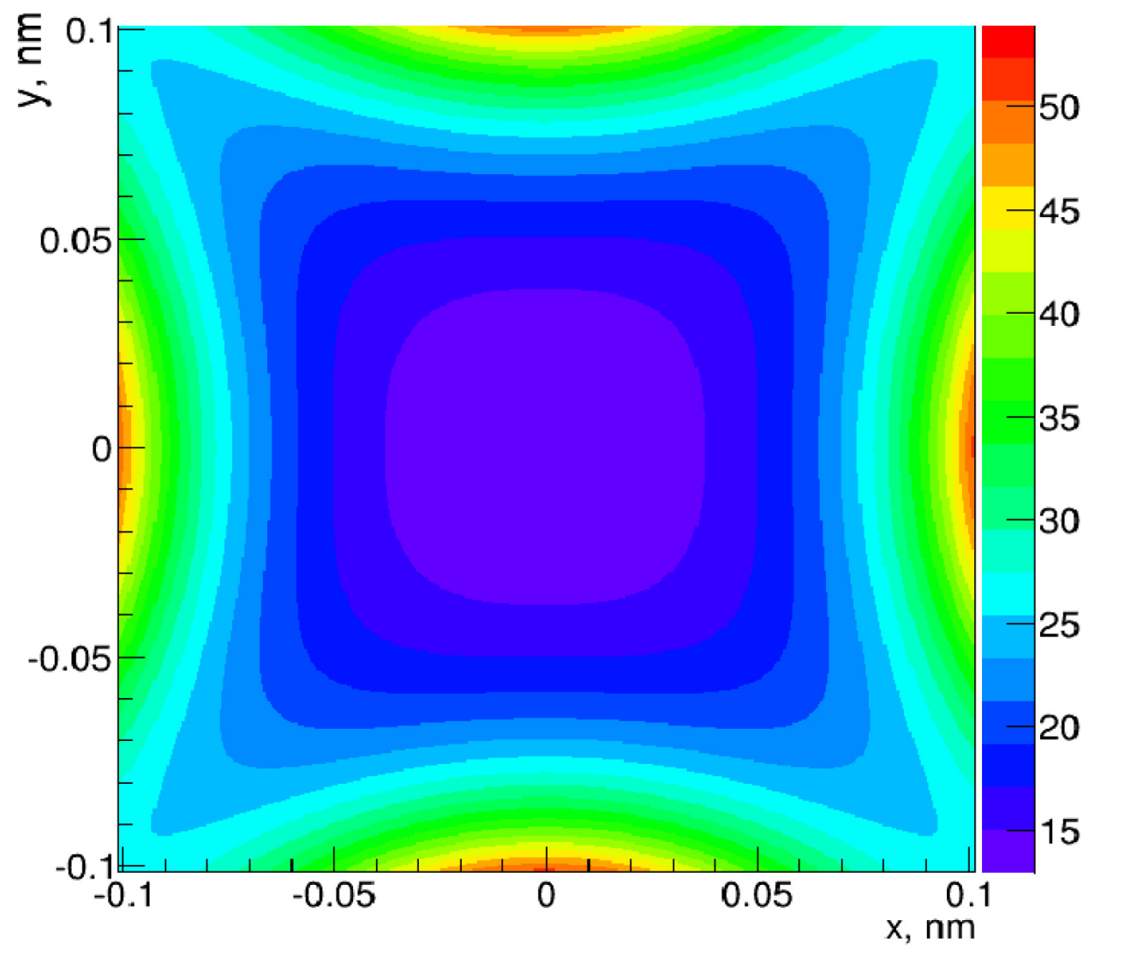
3p-state of Hydrogen atom by Dr. Winter

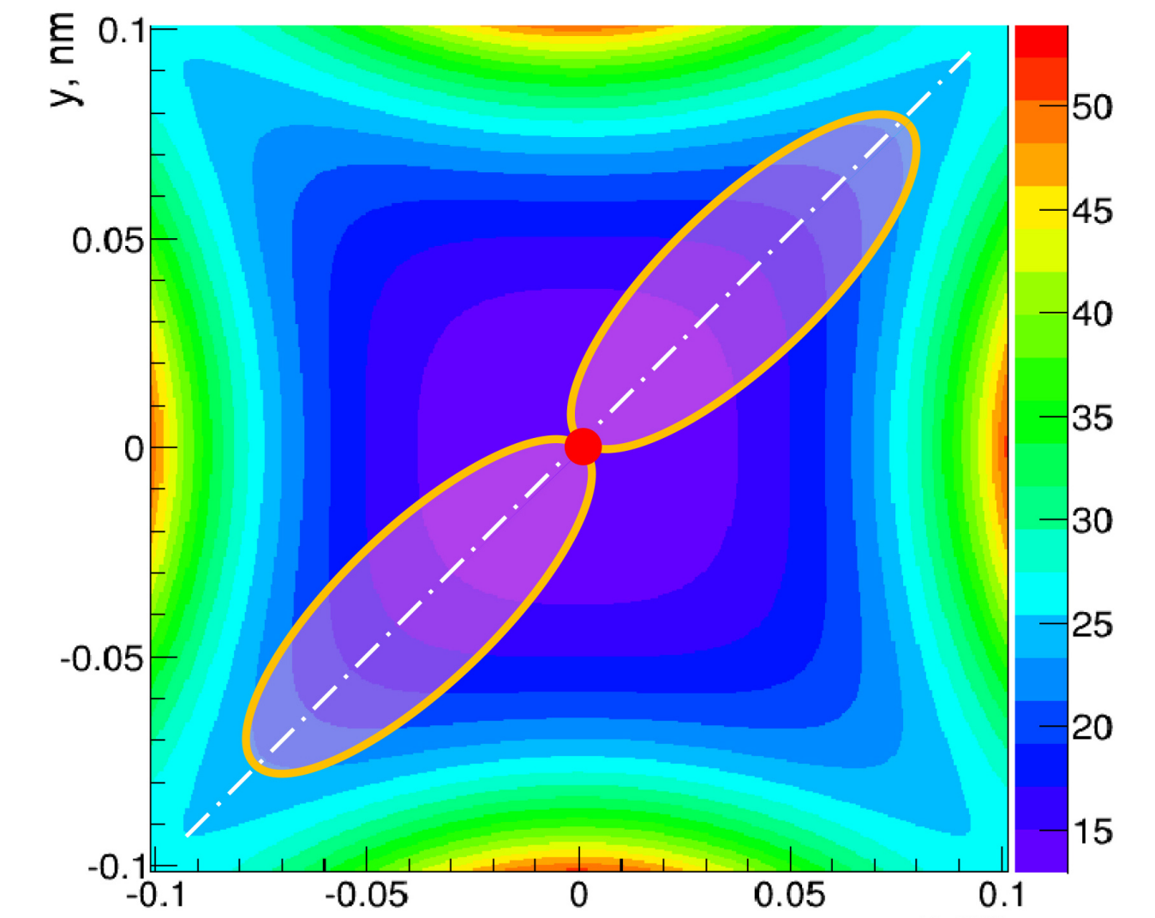


If target deuterium atoms were implanted in a metal crystal in accelerator experiments, a sharp increase in the probability of DD-fusion reaction was clearly observed when compared with the reaction’s theoretical value. The electronic screening potential, which for a collision of free deuterium atoms is about 27 eV, reached 300–700 eV in the case of the DD-fusion in metallic crystals.

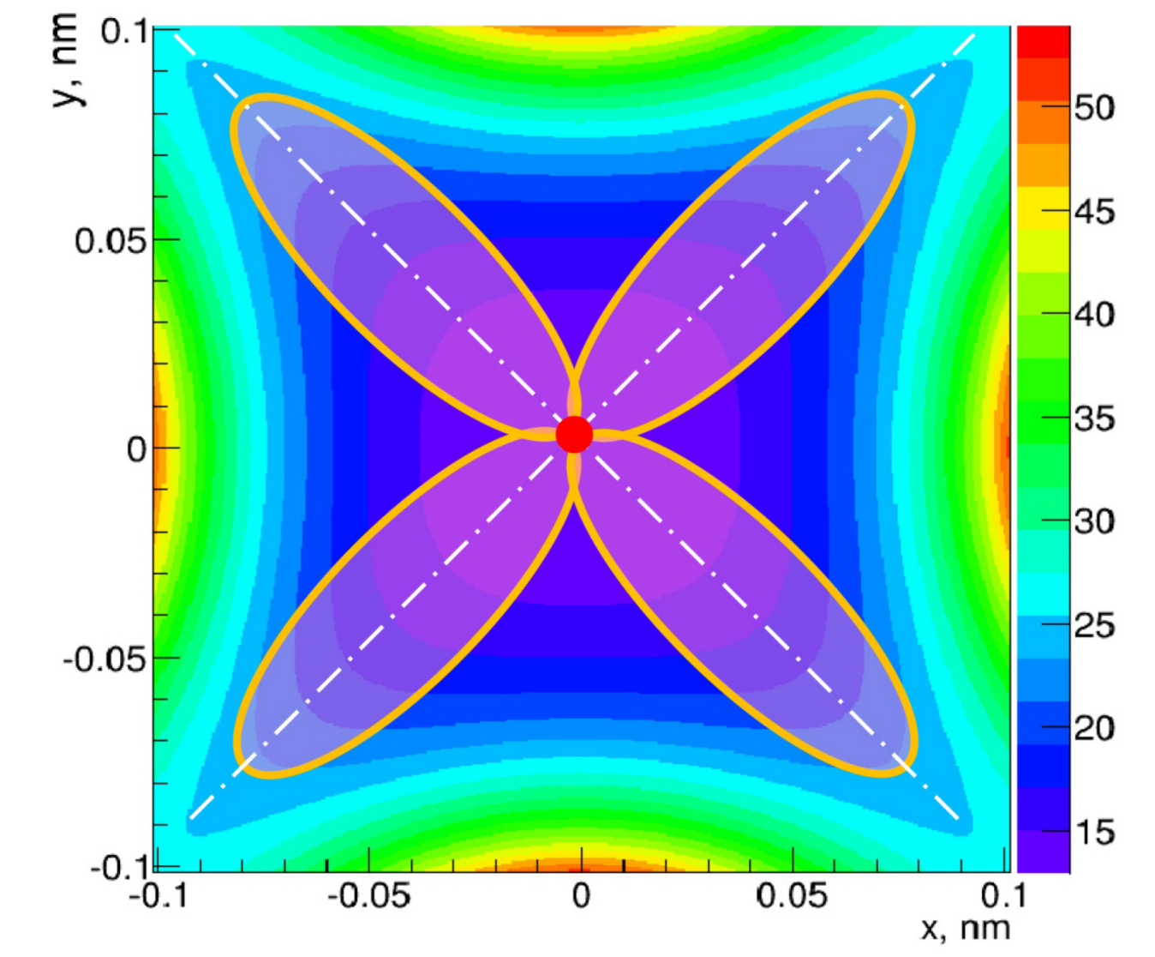
These data leads to the conclusion that a ban must exist for deuterium atoms to be in the ground state *1s* in a cell filled with free conduction electrons. At the same time, the state *2p,* whose energy level is only 10 eV above that of state *1s,* is allowed in these conditions. With anisotropy of *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 with reduced Coulomb repulsion at a very short distance from each other.

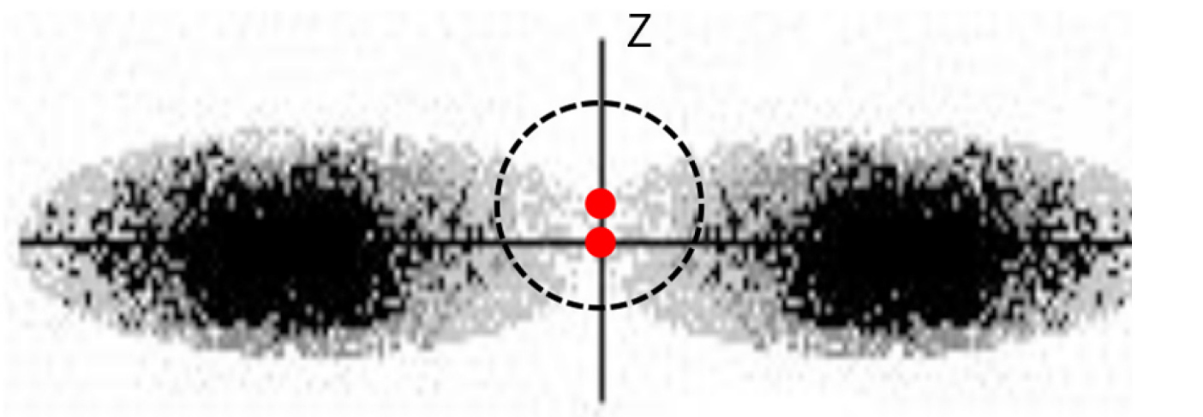




Octahedral platinum crystal niche filled with two deuterium atoms in *2p*-state



The case when two deuterium atoms in *2p*-state are located in the same octahedral niche of conducting *fcc* crystal, Z-direction, 45° rotation in *X-Y* plane.



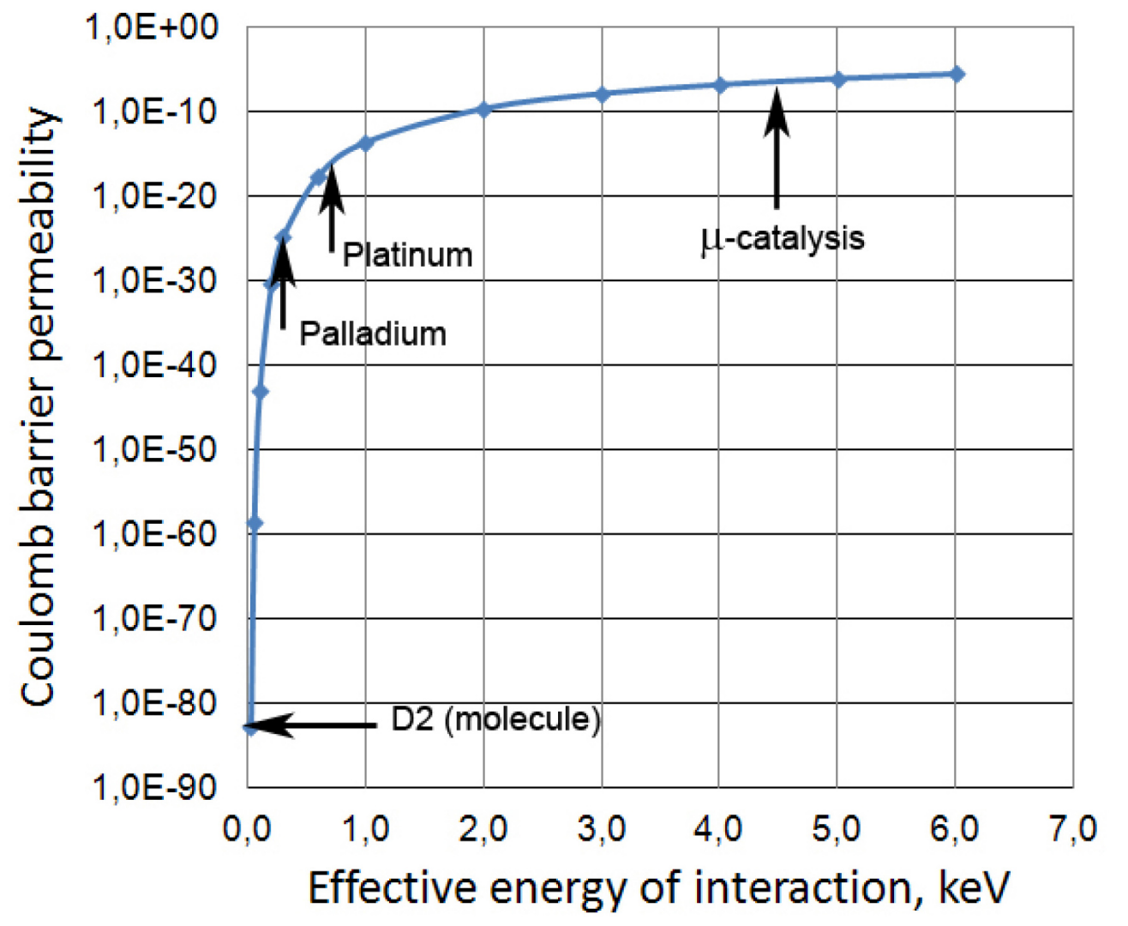
Note, the situation is quite similar to processes of μ-catalysis.

Thus, convergence distance of two deuterium impurity nuclei caught in the same crystalline niche of a metal is *at least an order of magnitude smaller than the size of the free atom of deuterium.*

Complete interpretation of this phenomenon still needs further elaboration, but many accelerator experiments leave no doubt for its existence. Coulomb barrier permeability in such conditions during the cold DD-fusion is *sharply increased* as compared to the permeability of the barrier in the case of the free molecule of deuterium.

Coulomb barrier permeability for DD fusion:

$$P = e^{-2\pi\eta};\ 2\pi\eta = 31.41/E_{eff}^{1/2},\ E_{eff} = E + U_e$$

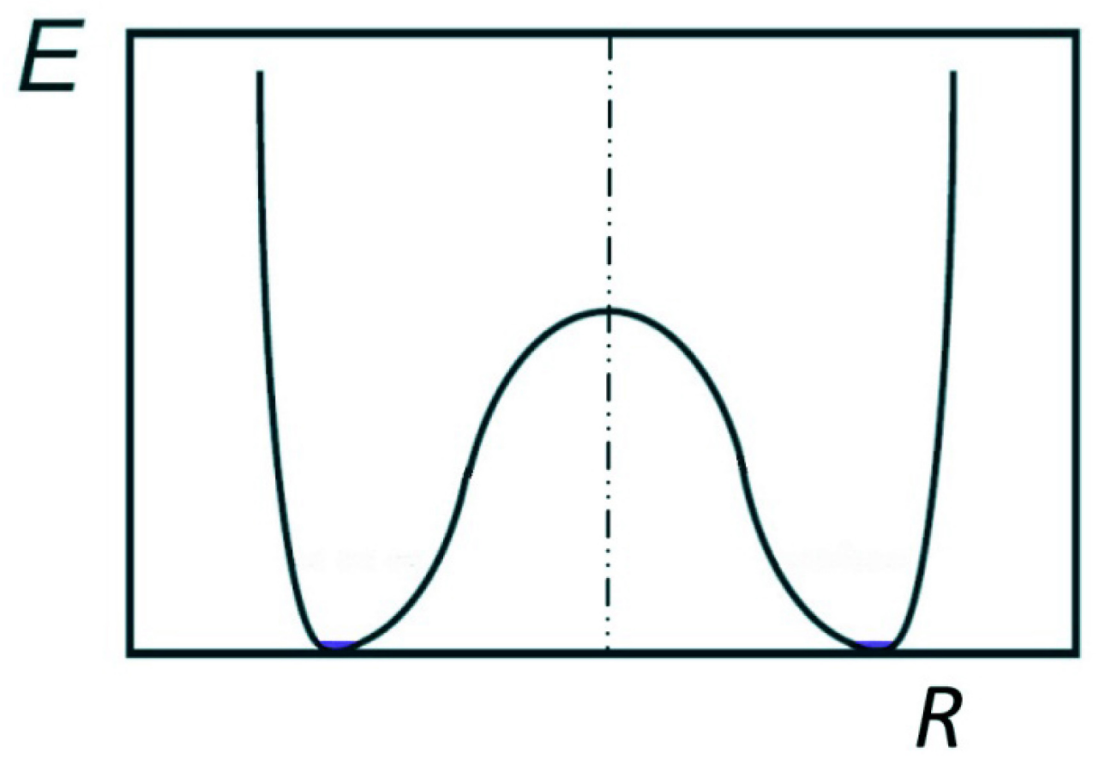


For cold fusion $E \cong 0.040$ eV

Pt/D2 ≅ 10^{65}

We believe that first secret of cold DD fusion in conducting crystals is solved. The second surprise of the cold fusion process: *no standard nuclear decay products of ^{4}He* in these reactions.*

A possible reason of nuclear decay rate slowing with decreasing of the excitation energy: the *residual Coulomb barrier* between the deuterium nucl that already are in the potential well of the strong interactions.



One can assume that the potential inside of the Coulomb barrier well after the strong interactions of the fusion reaction is no longer a retaining factor for neutrons, and neutrons can almost freely move from one proton to another. In this case, the *metastable DD-system* goes into a *metastable PT-system.*

According to our *hypothesis*, the rate of nuclear decay of a compound nucleus ^{4}He* is a function of the excitation energy of the nucleus E_k. *We assume that when the $E_k \sim 0$, the compound nucleus ^{4}He* is metastable with a lifetime of about 10^{-15} s.* After a time of ~10^{-16} seconds, the compound nucleus is no longer an isolated system, since *virtual photons g** from the ^{4}He* can reach the nearest electrons in a crystal and carry away the excitation energy of the compound nucleus ^{4}He*.

It must be emphasized that the above hypothesis is merely an attempt to explain *the well-established experimental fact* of the virtual absence of nuclear decay channels of the intermediate compound nucleus ^{4}He* in the process of cold fusion.

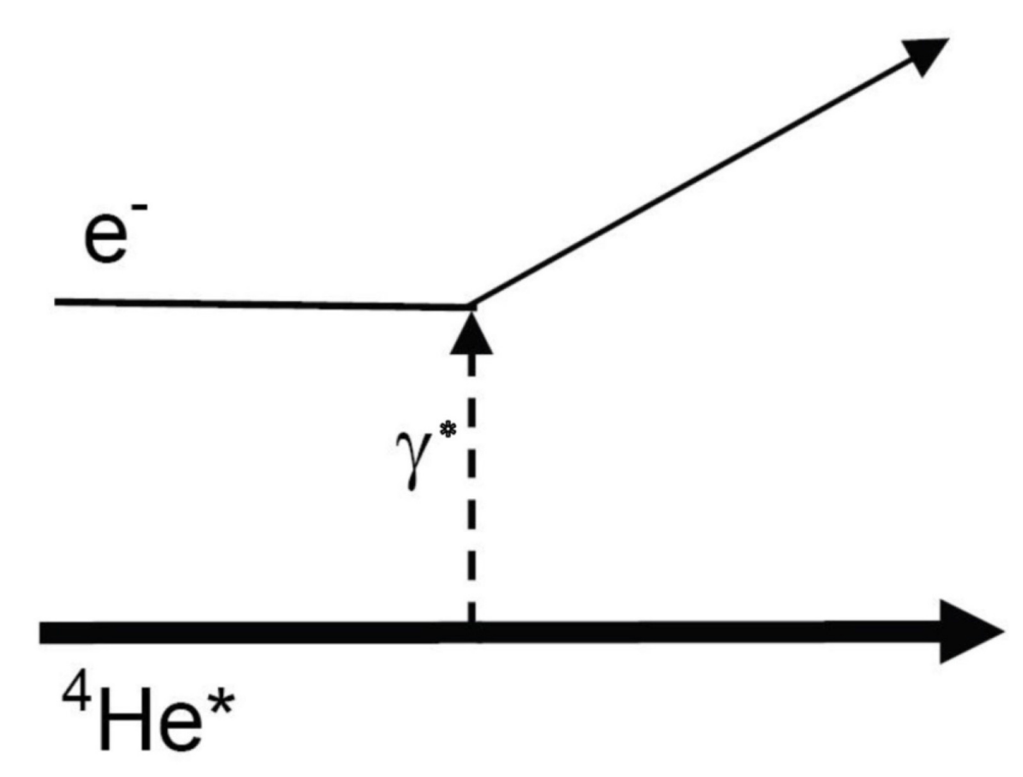
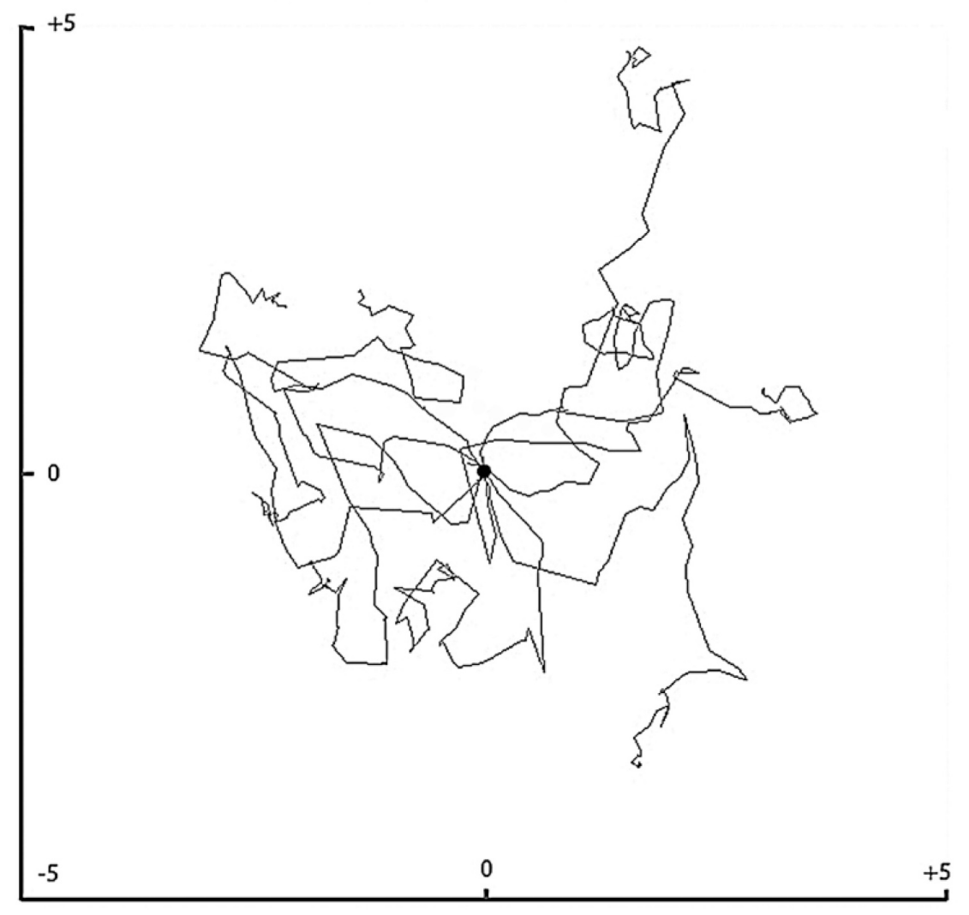


Diagram of “thermalization” process of ^{4}He* with multiple *virtual photon exchanges*. In order for this process to work, existence of a metastable state of ^{4}He* is necessary.

Trajectories of first 10 electrons (Monte Carlo) generated in the process of DD cold fusion in Palladium. Dimensions are in micrometers.



Our first publication, April 6, 2011

LNF–11/03 (P)
April 6, 2011

COLD NUCLEAR FUSION
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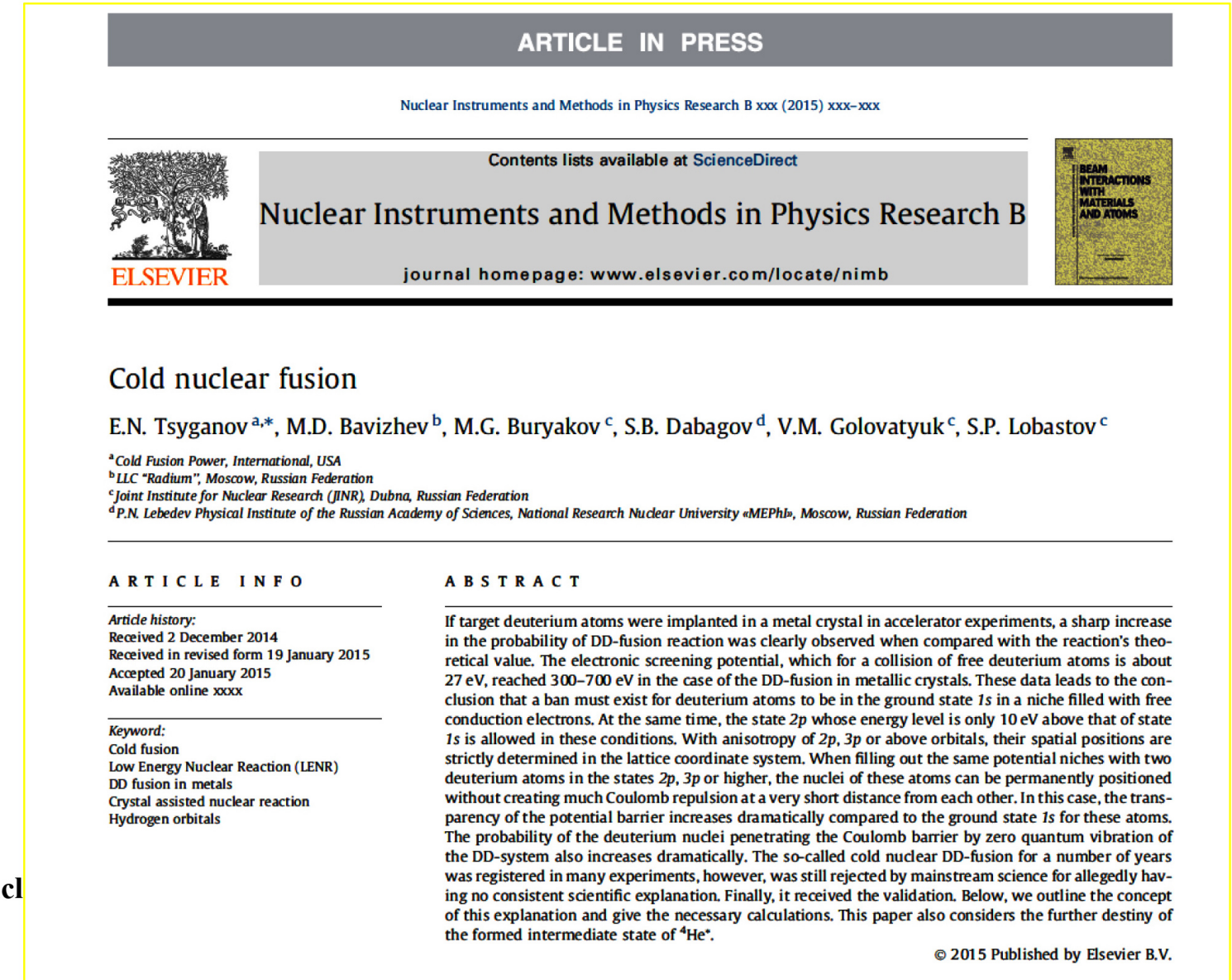
Abstract

Recent accelerator experiments on fusion of various elements have clearly demonstrated that the effective cross-sections of these reactions depend on what material the target particle is placed in. In these experiments, there was a significant increase in the probability of interaction when target nuclei are imbedded in a conducting crystal or are a part of it. These experiments open a new perspective on the problem of so-called cold nuclear fusion.

Most promising version for practical applications would be Platinum (Pt) crystals, where the screening potential for d(d,p)t fusion at room temperature is about 675 eV [11]. In this case, DD fusion rate would be:

$$\lambda_{f(0.675\,keV)} = 4.2\ s^{-1}.$$



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Cold nuclear fusion

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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 ^{4}He*.

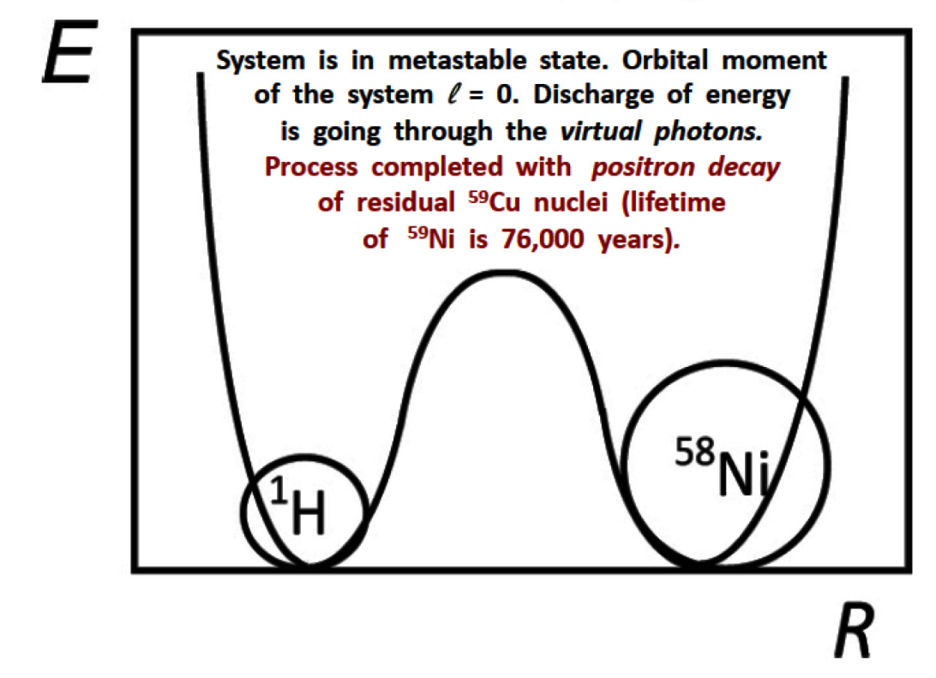
Talk at Peoples' Friendship University of Russia on January 28, 2015

Исследование аналога
высокотемпературного теплогенератора
Росси.
Новые результаты

Пархомов
Александр Георгиевич

Tsyganov E.N., Dabagov S.B., Bavizhev M.D.
“Cold fusion continues”, *XI International Scientific Conference: Solid State Chemistry: Nanomaterials, Stavropol, Russia on 22-27 April 2012, p. 51-57*

$$^{58}Ni + {}^1H \rightarrow {}^{59}Cu^* \rightarrow {}^{59}Ni + \beta^+ + \gamma^* + \nu_e$$

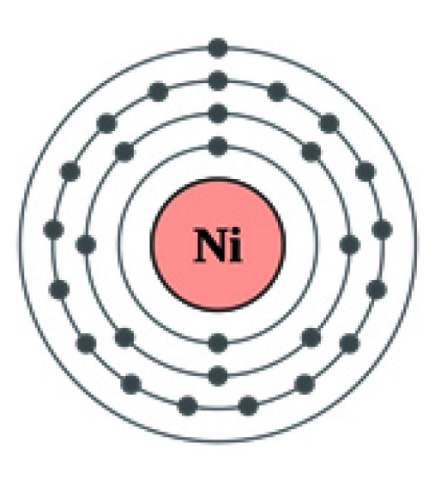


System is in metastable state. Orbital moment of the system $\ell = 0$. Discharge of energy is going through the *virtual photons.* Process completed with *positron decay* of residual ^{59}Cu nuclei (lifetime of ^{59}Ni is 76,000 years).

68.27%	$^{58}Ni+{}^1H\rightarrow{}^{59}Cu^*\rightarrow{}^{59}Ni+\beta^++\gamma^*+\nu_e$	1.3 min
	$^{59}Ni+{}^1H\rightarrow{}^{60}Cu^*\rightarrow{}^{60}Ni+\beta^++\gamma^*+\nu_e$	23.7 мин.
26.10%	$^{60}Ni+{}^1H\rightarrow{}^{61}Cu^*\rightarrow{}^{61}Ni+\beta^++\gamma^*+\nu_e$	3.3 min
1.13%	$^{61}Ni+{}^1H\rightarrow{}^{62}Cu^*\rightarrow{}^{62}Ni+\beta^++\gamma^*+\nu_e$	9.7 min
3.59%	$^{62}Ni+{}^1H\rightarrow{}^{63}Cu^*\rightarrow{}^{63}Cu+\gamma^*$	*^{63}Cu stable*
0.91%	$^{64}Ni+{}^1H\rightarrow{}^{65}Cu^*\rightarrow{}^{65}Cu+\gamma^*$	^{65}Cu stable
	(or $^{65}Cu^*\rightarrow{}^{61}Fe+\alpha$, $^{61}Fe\rightarrow\beta^-$ to ^{61}Co	6.0 min)

Here γ^* – multiple *virtual photons*

Nickel 28
2,8,17,1



Conclusions

1. Existence of the phenomenon of cold fusion now is conclusively proven by the experiments, including experiments on low-energy accelerators.

2. The absence of nuclear products observed in cold fusion experiments can be explained by slowing down the decay rate of a compound nucleus ^{4}He* *via* nuclear channels with decreasing energy of its excitation. Energy release is due to exchange to outside world by *virtual photons* when their spin *“directed along the time axis”.*

3. Prejudice of many nuclear physicists toward the cold fusion phenomenon is associated with this unusual nuclear process. In the cold fusion process, the resulting intermediate compound nucleus ^{4}He* is in a metastable state.

4. The accumulated empirical rules of nuclear physics are considered by the nuclear physics community as indisputable, while the range of application of these rules is limited.

5. Cold fusion provides sufficiently more practical opportunities than the expected traditional thermonuclear fusion.

Some of the applications of cold fusion (ships, aircraft, and space travel) are simply unavailable for devices of cyclopean scale — tokamaks and other hypothetical facilities using thermonuclear fusion.

It seems to me, cold fusion in conducting crystals would take its rightful place in the important science and industry in the near future, if would not being hastily resisted by orthodox scientists. The scientific community’s process of adaptation to new knowledge has never been easy. The current paradigm of nuclear physics does not support effects such as cold fusion, although this phenomenon does not contradict any of the fundamental laws of nature. All this is aggravated by the fact that the attempt to find a solution to controlled nuclear fusion — which has been conducted for nearly half a century — has gone too far.

The most advanced attempt in this direction is called the International Project ITER — Tokamak. Currently under construction, the project is cyclopean in size and equally costly. Realists estimate that the construction of the Project and the start-up of the facility should be completed within the next 35–50 years. The project is only considered to be a research project and will only be able to operate in a cyclic mode.

After ITER launch, it will be followed by the construction of even more gargantuan structure: Industrial Tokamak DEMO. The prospect of huge financial and material costs should continue for another half century.

For the global fuel and oil–gas industry, these projects are welcome. In the worst-case scenario, such developments will contribute to climate change and its attendant problems: the reduction of the human population and other social cataclysms. Cold fusion is a real alternative to this tragic scenario. We believe that in the coming years, the awareness of cold fusion’s scientific merits will be recognized, and a radical change will occur in the practical applications of nuclear research.

ITER, March 2015

Welcome to our website:

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