Seminar BLTP, JINR
July 7, 2014

In agreement with the Directorate of the Bogolyubov Theoretical Physics Laboratory, JINR, I made a presentation on July 7, 2014 at an LTP seminar named “DD Fusion in Conducting Crystals.” Although I spoke relatively recently on this topic at the Laboratory of High Energy Physics, JINR (in November 2012), rapid developments on the subject allow me to consider this LTP seminar quite timely.

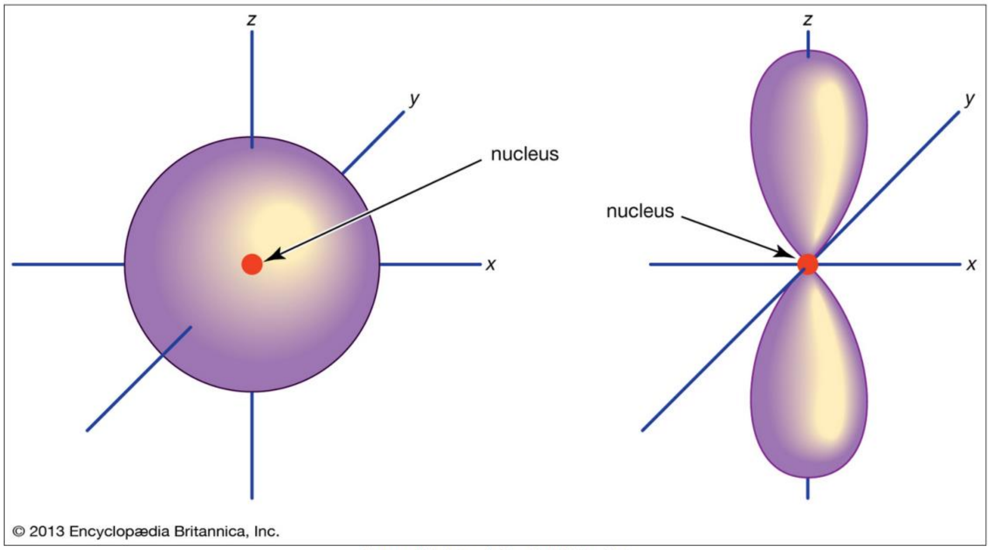
On July 21–27, 2013, the 18th International Conference on Cold Fusion (ICCF-18) took place at the University of Missouri in Columbia, Missouri, USA. This conference demonstrated the increasing interest of the scientific community in this natural phenomenon. The conference presented new experimental data on the cold fusion process and gave a possible theoretical interpretation of these results. The next conference, ICCF-19, will be held in the summer of 2015 in Venice, Italy. Perhaps some breakthroughs in the final understanding and acceptance of the cold fusion process may begin during ICCF-19.

Relatively recently, I managed to overcome a certain psychological barrier inherent to all nuclear scientists—disregard everything non-nuclear. “Let the chemists deal with it, our business is the nucleus and all connected within.”

For quite a while, an interesting behavior has been observed in numerous experiments with low-energy accelerators. The probability of DD fusion reactions increases when compared with its theoretical value if deuterium atoms are implanted in metal crystals. This effect was not observed in cases when targeted deuterium atoms were either free or implanted in semiconductors or insulator crystals. The so-called electron-screening potential for collisions of free deuterium atoms is about 27 eV, which characterizes the size of the deuterium atom. In cases of DD fusion in a metal crystal, the potential increases to approximately 300–700 eV. Essentially, this means that, under such conditions, deuterium atoms are able to approach each other without Coulomb repulsion to a distance of 1/10–1/20 of their nominal size when in a free state.

To understand what this could mean, see the following picture from the 2013 *Encyclopedia Britannica*:

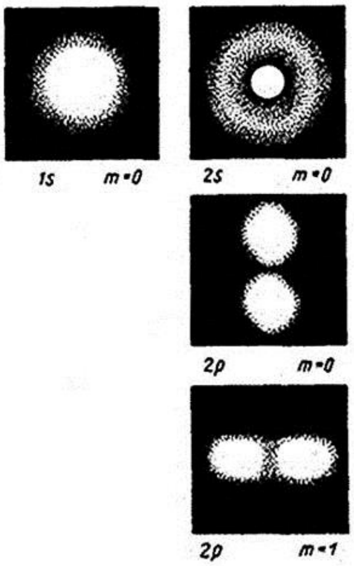
orbital: s- and p-orbitals

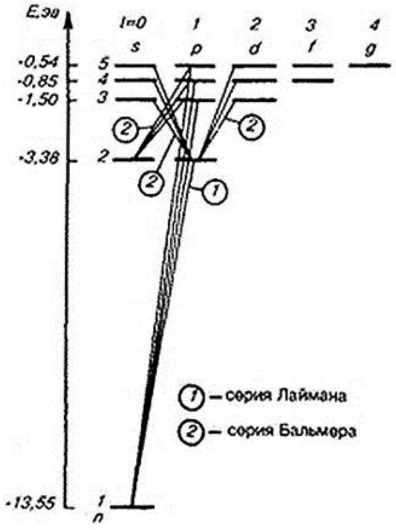


Electron orbitals in atoms (Left) *s* orbital; (right) *p* orbital

Encyclopædia Britannica, Inc.

In this figure, on the left is a schematic representation of the unexcited orbital of the hydrogen atom in a ***1s*** state, while on the right is the orbital of the first excited state of hydrogen ***2p***. Excitation energy in the ***2p*** state is only about 10 eV. Data on the high potential of electron screening during a DD reaction in conducting crystals filled with so-called free-electron conductivity (300–700 eV) could mean nothing more than a prevention of the deuterium atoms to exist in a ***1s*** state under these conditions. At the same time, in this conducting medium, the ***2p*** state is permitted.

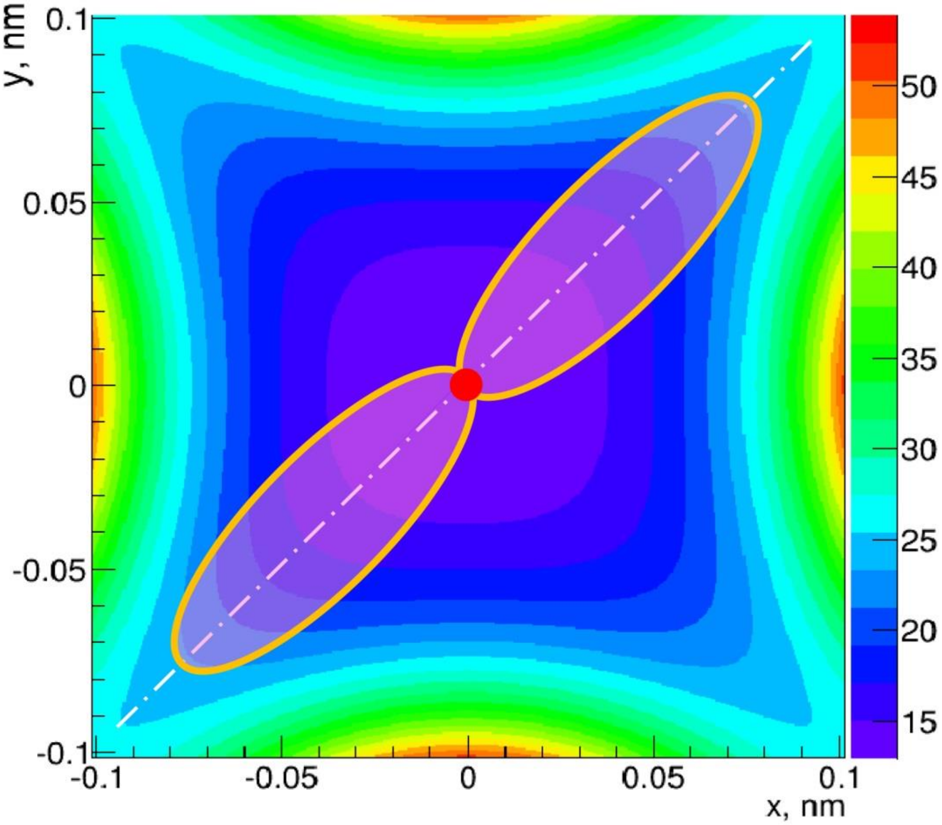




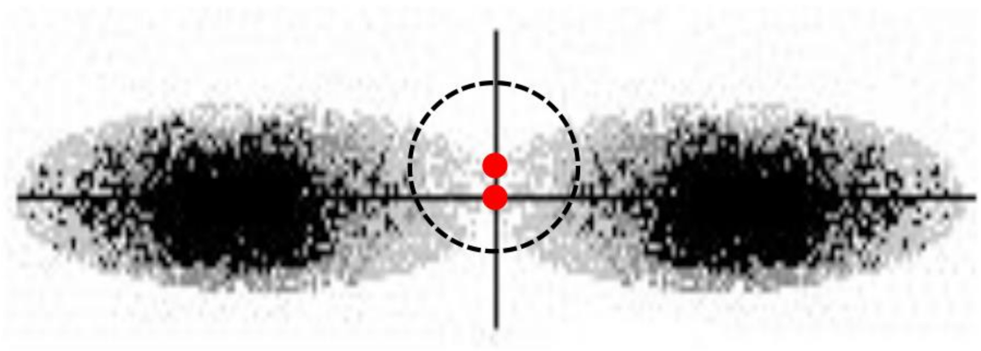
The figure above shows a graphic image of the first excited orbitals of the hydrogen atom and the corresponding electron energy levels.

Spatial orientation of the ***2p*** state in the structure of the crystal lattice happens to be quite deterministic of the main directions of the crystallographic lattice. While filling a crystallographic niche, two deuterium atoms in the ***2p*** state or above could bring two deuterium nuclei located in the same potential niche to a very short distance apart. In this case, the “zero” quantum vibrations of adjacent deuterium nuclei cause a sharp increase in the probability of DD-fusion reaction.

The figure below shows the location of the hydrogen (deuterium) atom in a crystal cell. Color scale indicates the electric field in the cell in volts. The spatial arrangement of the deuterium atom in the ***2p*** crystal state is strictly deterministic.



The next figure is a schematic arrangement of the two deuterium atoms in the ***2p*** state in the same crystallographic niche.

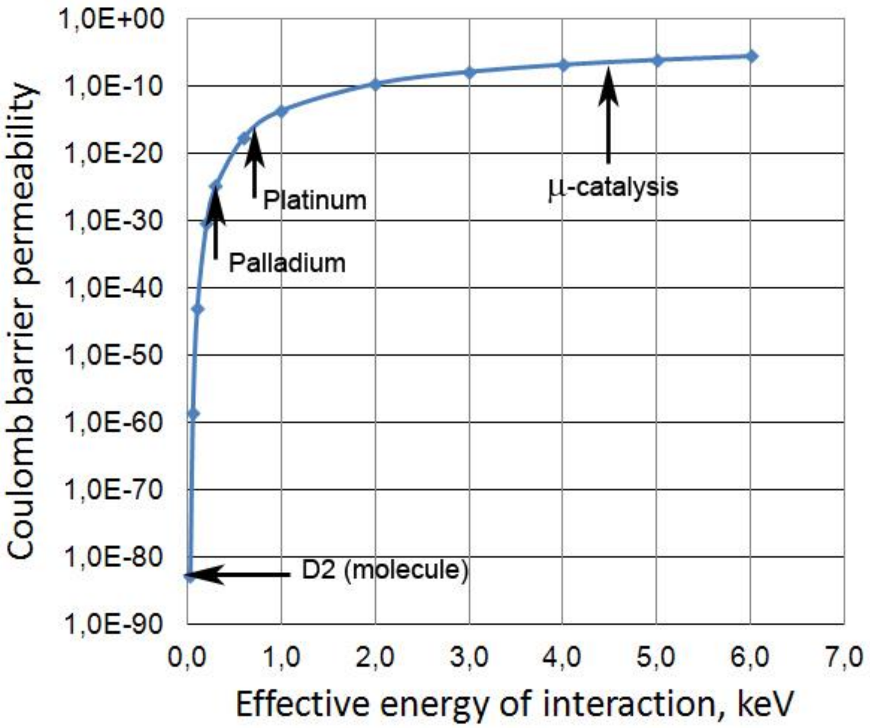


The following figure presents the transparency dependence of the Coulomb barrier for this reaction on the electron screening potential.

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 ($E \cong 0.040\ eV$), the ratio of the Coulomb barrier for the transparency of deuterium atoms in the same platinum crystal niche to the corresponding value for the free molecule of deuterium is Pt/D2 $\cong 10^{65}$.



As a conclusion, after this BLTP seminar, I would like to say the following:

Currently, there are sufficient experimental data confirming the existence of the phenomenon of so-called cold fusion in the case of saturation of conductive crystals by deuterium atoms. This is because the deuterium atoms that are implanted in the metal crystals exist therein in an excited state of ***2p*** or higher. Besides, the standard nuclear decay modes of the intermediate nucleus ^{4}He* are slowed considerably. The explanation of this process is based on the effect of the residual Coulomb repulsion barrier, already in the potential well of strong interactions. In this case, the "discharge" of nuclear energy of 24 MeV released by the reaction of DD → ^{4}He* can be done by virtual photons, whose spins are directed along the axis of time.

The scientific community's adoption of brand-new knowledge is often not an easy process. The current paradigm of the entirety of nuclear physics cannot explain such an effect as cold fusion, although this phenomenon does not contradict any of the fundamental laws of nature. All of this is exacerbated by the fact that attempts to find a solution to control nuclear fusion have already been pursued for approximately 50 years and, indeed, have gone too far. The most advanced attempt is an international project called ITER—which studies tokomaks of cyclopean size and their corresponding financial value—that is currently under construction. Realists assess completion of the construction and start-up of this facility no earlier than the next 30–50 years. ITER itself is only a research project; after its launch, an even more cyclopean construction—the industrial tokomak—should begin. Prospects with even more financial and material spending are looming in the next 50 years.

This process is quite satisfactory for the global fuel, oil, and gas industry. Climate change, reduction of the human population, social upheavals—all are what our society may inherit in this worst-case scenario.

Cold fusion, which was discussed during my seminar, is the real alternative to this tragic scenario. We believe that, in the coming years, the scientific success of the so-called cold fusion process will be recognized and that radical change in adopting this nuclear research will begin.

I personally believe that the Joint Institute for Nuclear Research will find an opportunity to make a decisive contribution to this research area.

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