Roundtable discussion on cold nuclear fusion on the Channeling 2014 Conference, October 8, 2014, 18:30

At the Channeling 2014 Conference, during the roundtable session on "cold" nuclear fusion, some of the participants suggested that we avoid rushing to promote cold fusion and, therefore, prevent any interference with the implementations of ITER. However, it is difficult to ignore cold fusion because it is much less expensive than traditional nuclear fusion. We have tried to concisely summarize this option with a sample fusion of deuterium atoms that were implanted in metal crystals with large atomic numbers. The reader has the ability to find all of the necessary references in our PowerPoint report on Conference Channeling 2014, which also available on this site.

COLD NUCLEAR FUSION

Will be submitted in NIMB on the materials of Channeling 2014 Conference

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In the series of Japanese accelerator experiments on DD fusion with low energies, started in early 1995, an increase in the cross section of the reaction as compared with its theoretical value in the medium of metallic crystals was observed. Somewhat later, this effect was reliably observed in conducting crystals in the underground laboratory of Gran Sasso (LUNA collaboration), as well as in the experiments of the Czerski Group in Berlin. Also, it has been confirmed that this effect does not occur if the targets with implanted deuterium were semiconductors or insulators.

If the incident deuteron velocity in solids is less than the so-called Bohr velocity of the electron in the hydrogen atom, deuteron acquires its own electron from the medium and then moves in a solid as an atom. For deuterium, this threshold is about 50 keV. Refer, for example, to the work of Leningrad physicists (YA Baranov, Yu. Martynenko, SO Tsepelevich, Yu. N. Yavlinsky, *Physics-Uspekhi,* November 1988, Volume 156, no. 3, p. 477). Thus, in the DD reaction that occurs in crystal media, deuterium atoms, but not bare nuclei, are colliding. In the case of the collisions of free deuterium nuclei, the energy dependence of the two main DD reactions is shown in Fig. 1:

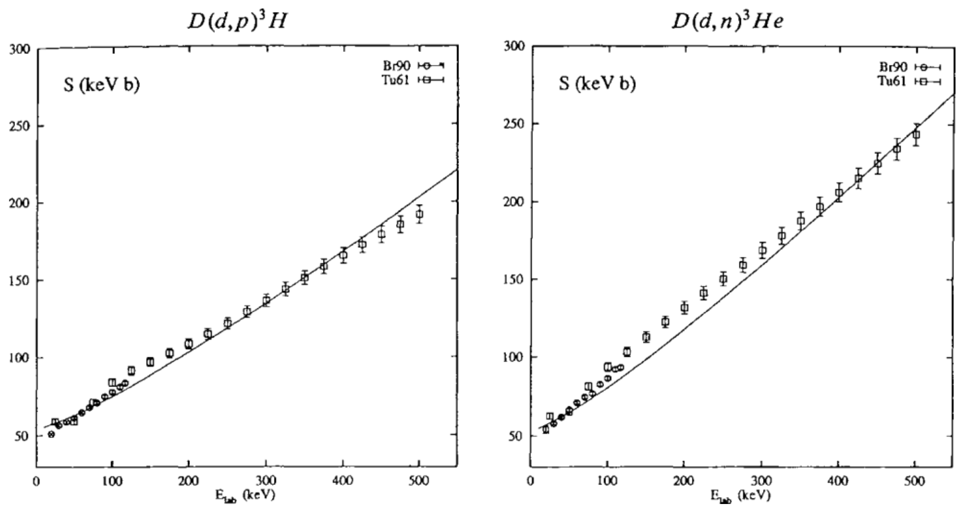


Fig. 1. In the case of DD collisions, the astrophysical functions *S(E)* for the reactions $D(d,p)^3H$ and $D(d,n)^3He$ behave as shown in this figure.

At the same time, these two basic DD reactions experience a sharp rise in the so-called astrophysical factor *S(E)* at low energies if the target atoms are implanted in the conducting crystals. Fig. 2 shows the behavior of *S(E)* for the reaction d(d,p)t for deuterium that is implanted into platinum (LUNA collaboration). Experimental data is fitted with the introduction of additional screening potential U_e. This screening potential in the case of a platinum crystal was quite large; about 675 eV. In the case of a collision of free deuterium atoms, this potential is 27 eV, which corresponds to the size of unexcited hydrogen atoms.

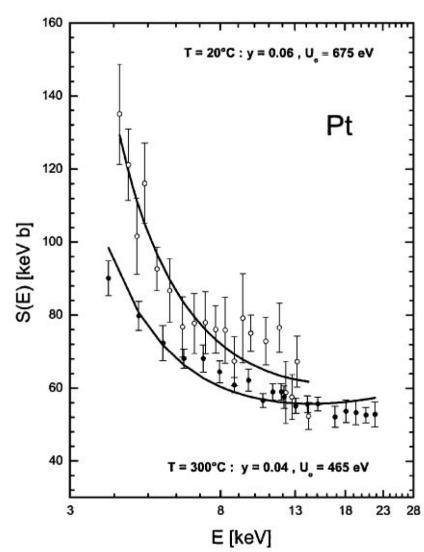


Fig. 2. The energy dependence of *S(E)* for screening potential for DD fusion in the platinum crystal. The screening potential is equal to 675 eV.

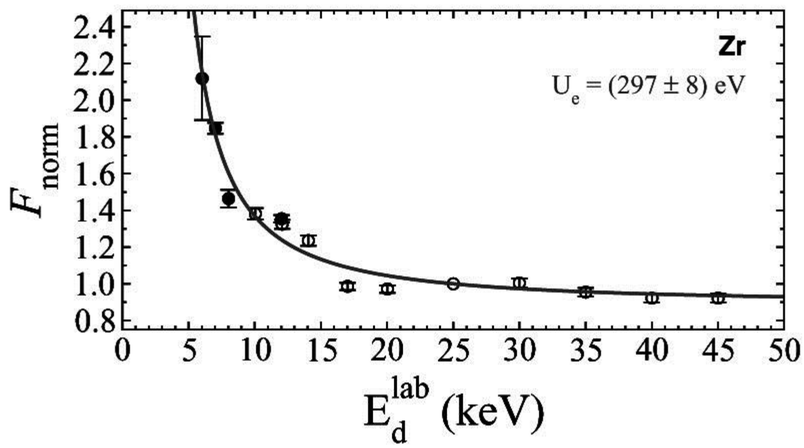


Fig. 3. The energy dependence of the astrophysical factor *S(E)* for DD fusion in a crystal of zirconium. The screening potential is equal to 297 eV.

Fig. 4 shows a diagram of the excitation of the electronic levels of the hydrogen atom. Pay attention to the ***2p*** state, which is only 10 eV above the ground state of the unexcited state ***1s***.

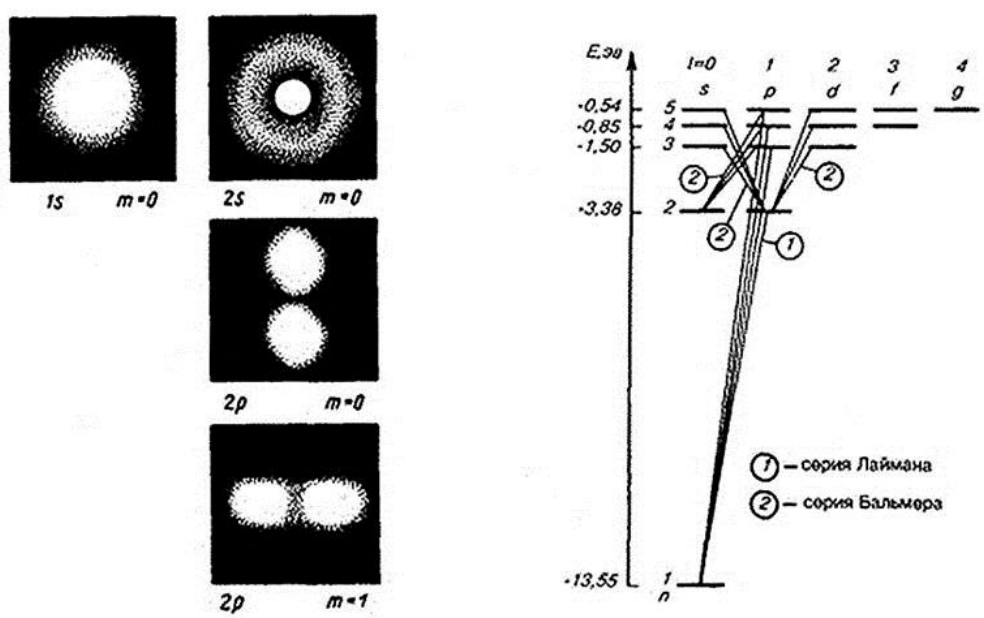


Fig. 4 The scheme of the excitation levels of the hydrogen atom.

Fig. 5 is a schematic representation of the orbitals of hydrogen in the state ***1s*** and ***2p*** from Encyclopædia Britannica, Inc.

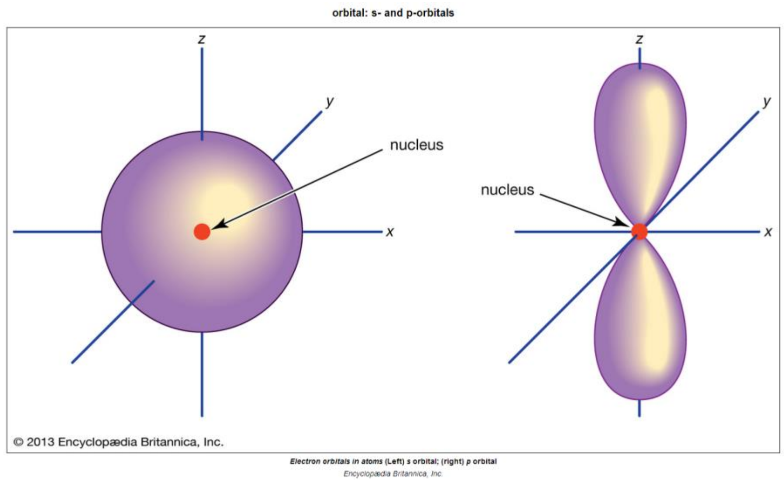


Fig. 5 The graphic representation of the orbitals of the hydrogen atom in a state of ***1s*** and ***2p***, from © 2013 Encyclopædia Britannica, Inc.

Conduction electrons already located in the crystallographic niche of metallic crystals. This means that ***1s*** (in Fig. 5 left) cannot be implanted into this niche which occupied by these electrons. The ***2p*** state (in the figure on the right) allows for such a possibility. In essence, the above circumstance is the full explanation of the initial stage of cold fusion.

Fig. 6 displays the orbitals (the solution of the Schrödinger equation) for the hydrogen atom ***2p*** and ***7p***, as found in the work of Mark Winter at the University of Sheffield.

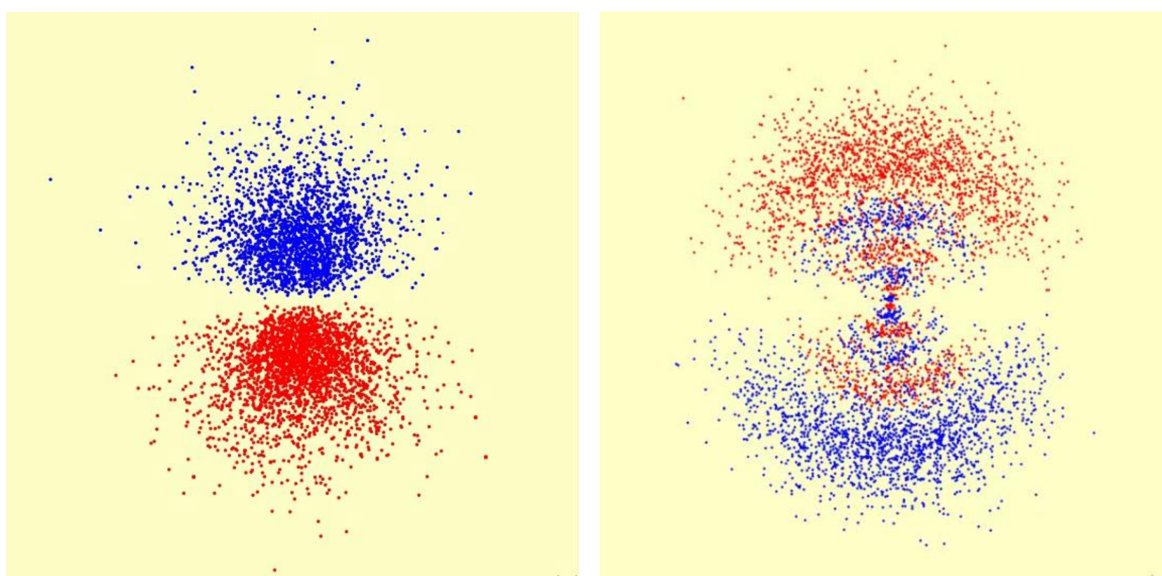
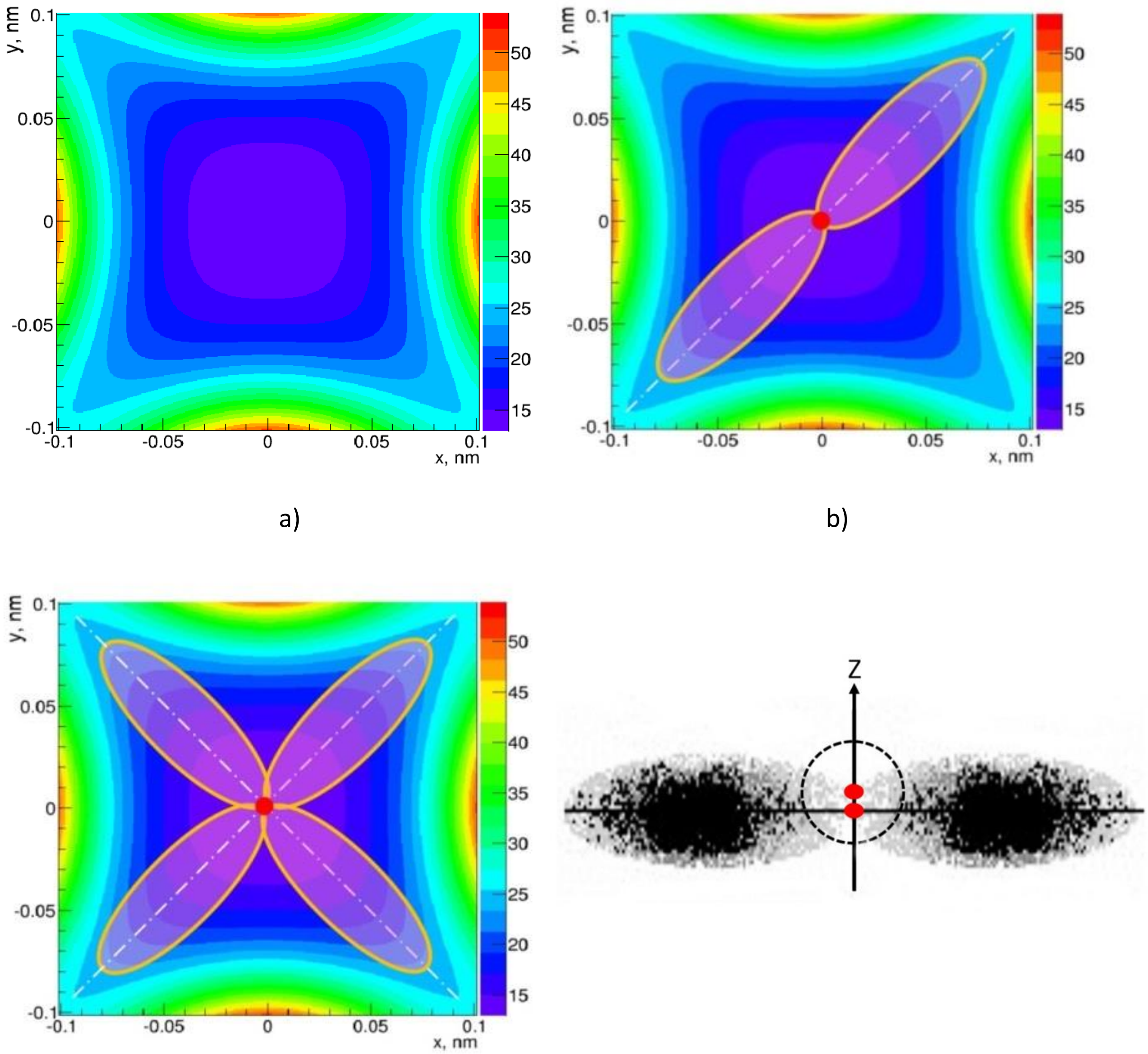


Fig. 6. The presentation of orbitals (the solution of the Schrödinger equation) of the hydrogen atom ***2p*** (left) and ***7p*** (right).

The mechanism of cold fusion in conducting crystals is illustrated in Fig. 7.



a) b)

c) d)

Fig. 7. The filling of a single platinum niche (fcc) with two atoms of deuterium (in the XY plane and along the vertical axis Z). The color scale is given in volts. Case a) an empty niche in the platinum crystal plane XY, with Z = 0, b) a niche filled with one atom of deuterium, and c) a niche filled with two deuterium atoms; d) is the same as c), but differs in terms of the direction of the vertical axis Z.

Transparency of the potential barrier for the reaction of DD fusion is shown below. The U_e screening potential in this case acts as additional energy.

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

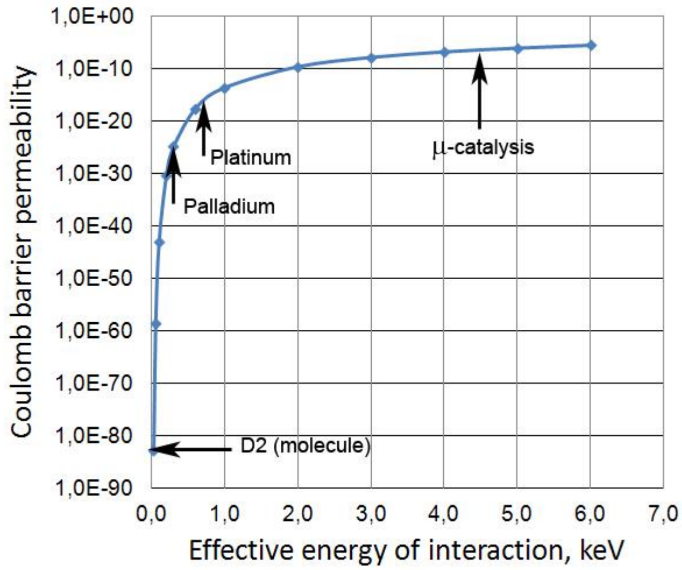


Fig. 8. The transparency of the Coulomb barrier for the reaction of DD in the crystal depending on the effective interaction energy E_{eff}.

For cold fusion *(E ≃0,040 eV),* the ratio of transparency of the Coulomb barrier for deuterium atoms in the same niche of the crystal platinum compared to the corresponding value for the free molecule of deuterium is Pt/D2 $\simeq 10^{65}$. Actually, this unexpected circumstance makes cold fusion in conducting crystals possible.

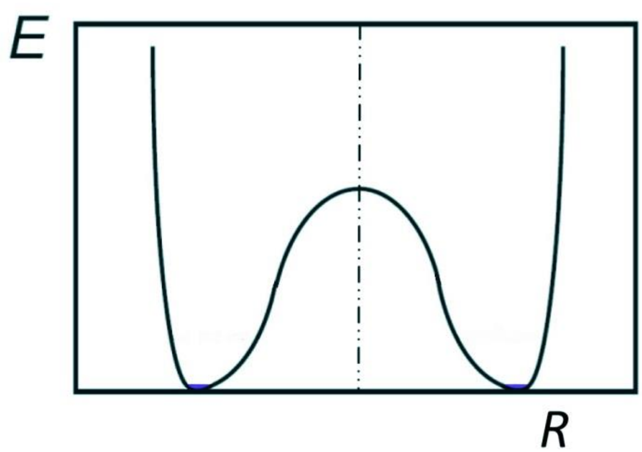


Fig. 9. A schematic representation of the potential at the bottom of the well of strong interactions in cold DD fusion in a conducting crystal. The excitation energy of $^4He^*$ is heat energy, about 0.040 eV. Deuterons, penetrated into the potential well through the mechanism of cold fusion, are still divided as before by the residual Coulomb barrier.

It is natural to assume that the residual Coulomb barrier between the nuclei of deuterium already inside the potential well of strong interactions, as well as the low excitation energy of the intermediate nucleus, slow down the two standard nuclear reactions in the process $^4He^* \rightarrow {}^3H+p$ and $^4He^* \rightarrow {}^3He+n$. This situation presented schematically in Fig. 9. It must be emphasized that the virtual absence of indicated reactions in the process of cold fusion is an undeniable experimental fact. The intermediate nucleus $^4He^*$ at low excitation energies happens to be in a metastable state, since the emission of a real gamma ray, in this case, is forbidden for objects with zero orbital angular momentum.

In this case, the release of the excess energy of $^4He^*$ can occur with *virtual* gamma rays when their spin is “directed along the time axis.” This process may take 10^{-18}–10^{-16} seconds. Fig. 10 presents such a process.

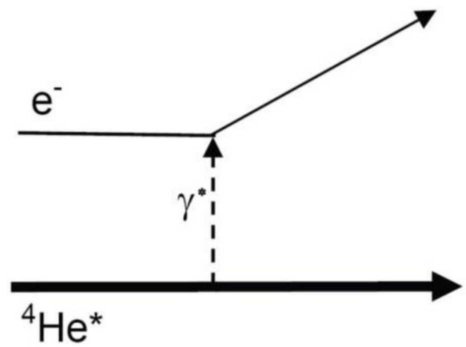


Fig. 10. The discharge of the excess energy of the intermediate nucleus $^4He^*$ with the help of a series of successive exchanges of virtual photons of this nucleus with the environment in a conducting crystal. For this mechanism to work, a metastable state of $^4He^*$ is necessary.

Fig. 11 displays the trajectory of the first 10 electrons generated using the Monte Carlo process of cold DD fusion in palladium. The dimensions are in micrometers. Note that the range of electrons is less than a few microns.

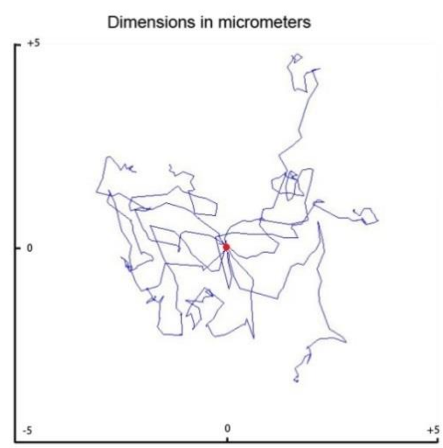


Fig. 11. The paths of the first 10 electrons generated using the Monte Carlo process of cold DD fusion in palladium. The dimensions are in micrometers.

The scientific community has always had trouble adapting to truly new knowledge. The current paradigm of nuclear physics does not contain effects such as cold fusion, although this phenomenon does not contradict any of the fundamental laws of nature. Attempts to generate controlled nuclear fusion, which have been conducted for nearly half a century, have already come a long way. The most advanced attempt, ITER – a tokamak of cyclopean size and corresponding value – is currently under construction. Realists assess that this facility will take 35–50 years to complete and commence operations. It is only considered as a research project and is expected, after its launch, to start even more gargantuan industrial tokamak. The prospect of huge financial and material spends for another half century looms.

Oil and gas can no longer serve as global fuel, due to its exhaustion, while the companies will try to fight back. This way also may well lead to climate change, a population reduction, and social upheavals.

Cold fusion is a real alternative to this tragic scenario. We believe that in the coming years, the scientific success of cold nuclear fusion will be realized and a radical change in the applied nuclear research will come.

Unfortunately, cold fusion still seems to be quite distant from wide recognition, even though the issue is now practically solved in experimental and theoretical terms. At the moment we are facing a problem that is not scientific but sociological. It is difficult to predict how fast events will develop in this direction. A paradigm shift in science has never been an easy task for society. We should propose the optimal behavior for scientists in these circumstances.

A full PowerPoint file of my report on Channeling 2014 is contained here:

https://www.dropbox.com/s/2luysgmftjmcd1u/capri%202014-3.pptx?dl=0

Additional information can be found at:

http://www.coldfusion-power.com/dubna-jinr.html

We would be extremely grateful to our readers for their response to this message. We hope for your support.

Sincerely,
E.N. Tsyganov