Comments on the E.N. Tsyganov materials “Cold nuclear fusion”

The idea of the feasibility of a cold fusion reaction in a glass of heavy water during electrolysis as a result of the dissolution of deuterium in palladium electrodes goes back to Fleischmann and Pons (1986) and has periodically generated interest, including in scientific circles.

It is known that for the fusion reaction d + d -> ^{3}He + n, deuterons should be able to approach each other at the distance of $R^{*}\sim10^{-11}$ cm. This distance is necessary in order to increase the cross section of the reaction to a value that ensures that it is going on in the laboratory. Typically, nuclei’s approaching each other to such a distance has to be carried out in plasma heated to a sufficiently high temperature. Indeed, in order to overcome the Coulomb repulsion of the nuclei at these distances, the plasma must be heated to a temperature of $T \sim e^2/R^* \sim 10^4$ eV. This approach is the basis of a number of systems with magnetic plasma confinement (tokamaks) or inertial fusion plants, where heating of the plasma is carried out in the field of a high-intensity short laser pulse.

An alternative approach (so-called μ-catalysis of nuclear reactions) has long been known, where the nuclei approach the required distance at the expense of the chemical bond in a muon molecule of deuterium ddμ. The size of this molecule, as shown by the elementary quantum-mechanical calculations, is about 200 times smaller than conventional molecules of hydrogen (in which the distance between the protons in a steady state is about 0.74 A).

It is known that palladium or platinum plates can actually be regarded as reservoirs for hydrogen (deuterium) storage. E.N. Tsyganov’s approach to the justification of the possibility of the fusion reaction that occurs in deuterium dissolved in the crystal Pt (Pd) is, in fact, an attempt to justify the possibility of a significant decrease in the distance between deuterons by dissolving them in deuterium. This interpretation of the fusion reaction in the crystals of Pt (Pd) is absolutely invalid. Indeed, as we have already noted, the characteristic value of the inter-nuclear distance in the molecule of hydrogen (deuterium), as well as in any other molecule, is of the order of atomic size. For this spatial size from the most common quantum-mechanical representations appraise the energy scale of ~ 10 eV. At shorter distances, the electron density localized between the nuclei cannot ensure their attraction to each other, compared with the Coulomb repulsion. This problem is considered in the 20-ies of the last century (Heitler–London theory) and is contained in any textbook on quantum mechanics. In this case, the minimum distance between the nuclei is achieved for the case when the electron shells are at 1s states. If we place one (or both) of the atoms in an excited state (e.g., 2p), this will lead to an increase in the inter-nuclear distance. This is quite understandable in the framework of the already mentioned Heitler–London theory. The proximity of nuclei of a distance of less than 10–20 equilibrium one leads to an increase in the energy of their Coulomb repulsion to ~ 100 - 200 eV. What forces keep them at such distances in the crystal lattice with a characteristic size of the order of atomic size is absolutely unclear. Moreover, it is impossible in principle.

If, however, the author wants to convince the scientific community—at least those who are a little familiar with quantum theory—of his rightness, he should not be limited just by pictures of the energy levels and wave functions of the hydrogen atom, which can be found in any college textbook on nuclear physics and which he apparently interprets incorrectly. Instead, it is necessary to carry out the normal quantum mechanical calculation of structure, simulating the field of the crystal lattice of palladium or platinum and putting in the resulting potential field two atoms of deuterium. Instead of such calculations, the materials presented by the author give only verbal speculations that are far from reality.

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