On the Absence of Photons with 6.25 MeV and Neutrons with 14.1 MeV in CF Experiments

Hideo Kozima
Department of Physics, Faculty of Science, Shizuoka University
836 Oya, Shizuoka 422
Japan

Abstract

Riddles of the absence of 6.25-MeV photons and 14.1-MeV neutrons in the Cold Fusion (CF) phenomenon are investigated in the TNCF model. It is shown that the neutron and photon channelings through the crystal lattice make reactions with occluded deuterons on interstitial sites effective, and they disappear or stay within the crystal without going out to be detected.

1. Introduction

It has become now obvious that the CF phenomenon occurs in various systems generating excess heat and various kinds of nuclear products [1~3]. On the other hand, however, it is well known that there are no consistent explanations for all the experimental data of the phenomenon in this field [4]. The author presented a model [5-6] where the existence of a trapped neutron with thermal energy is assumed (TNCF model). The assumption of the TNCF model, the existence of trapped neutrons in the crystal, has been justified using ordinary Quantum Mechanics. In the papers presented hitherto by the author and his collaborators to explain the fundamental characteristics of the CF phenomenon by the model, concrete riddles were not treated intensively. The most mysterious riddles from our point of view are the absence of 6.25-MeV photons and 14.1-MeV neutrons in the experimental data. These two problems are the theme of the present paper and will be solved using the TNCF model.

Let's take up CF processes occurring in deuterides only (not in hydrides) in this paper. The TNCF model tells us that there occur CF reactions stochastically by the existence of the trapped neutron. The starting reaction is the trigger reaction between the trapped neutron with thermal energy and an occluded deuteron on an interstitial site:

$$n + d = t\ (6.98\ \text{keV}) + \gamma\ (6.25\ \text{MeV}) \qquad (1)$$

The products of this reaction, a triton and a photon, will induce following events in the sample.

First, the triton with medium energy (~ 7 keV) generated in this reaction makes interactions with occluded deuterons and with matrix nuclei. Let us take up now only the interaction with deuterons; elastic scattering and fusion and disintegration reactions:

$$t + d = t' + d' \qquad (2)$$

$$t + d = {}^4\text{He}\ (3.5\ \text{MeV}) + n\ (14.1\ \text{MeV}) \qquad (3)$$

$$t + d = t' + p + n \qquad (4)$$

The accelerated deuteron in the scattering (2) interacts with occluded deuterons and with matrix nuclei. Here again, we take up only interactions with deuterons:

$$d + d' = d'' + d''' \qquad (5)$$

$$d + d' = {}^3\text{He}\ (820\ \text{keV}) + n\ (2.45\ \text{MeV}) \qquad (6)$$

$$= t\ (1.01\ \text{MeV}) + p\ (3.02\ \text{MeV}) \qquad (7)$$

$$d + d' = d'' + p + n \qquad (8)$$

The neutron with energy of 14.1 MeV generated in reaction (3) interacts especially with occluded deuterons to accelerate and dissociate them besides the interactions with matrix nuclei:

$$n\ (14.1\ \text{MeV}) + d = n' + d' \qquad (9)$$

$$n\ (14.1\ \text{MeV}) + d = n' + p + n'' \qquad (10)$$

Those disintegration reactions (4), (8), and (10) are endothermic and can be a part of chain reactions for the breeding of nuclear products in an optimum situation but excess heat.

Secondly, the photon with an energy of 6.25 MeV generated in reaction (1) can dissociate an occluded deuteron to generate a proton and a neutron having energy of about 2 MeV each:

$$\gamma\ (6.25\ \text{MeV}) + d = p + n \qquad (11)$$

This is also the endothermic reaction.

The question raised in the interpretation of CF phenomenon within the limits of ordinary physics is the absence in the experimental data of the photon with an energy of 6.25 MeV generated in the trigger reaction (1) and the neutron with energy 14.1 MeV generated in reaction

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(3) [4].

About the 14.1-MeV neutron, however, there is the interesting fact of the experimental data of the 14.1-MeV proton [15]. When 150-keV deuterons were irradiated upon a Ti/D crystal target, a small but clear peak of protons at 14.1 MeV was observed. This result could be understood by a proton generated in the reaction (7), (8), (10), or (11) accelerated by an elastic collision at the near-surface layer with 14.1-MeV neutrons generated in the reaction (3).

First of all, in the investigation of reasons for the absence of those particles, it should be noted that an experiment to detect some new particle has to be planned to meet the object. It is necessary to prepare the apparatus having this point in the mind.

In the next section, we will give a qualitative explanation of the absence of those particles by effective exhaustion in the material used in the experiment.

2. Channeling and Nuclear Reactions of Neutrons and Photons in Crystal

It is well known that charged particles channel, or move freely in special directions, in a crystal lattice [16]. Neutral particles and photons also channel [17], and the character of their channeling is different from that of charged particles. One of the characteristics in neutral particles is the narrowness of the channel.

The relevant neutral particles, photons and neutrons, in our problem are special ones generated in the interstitial site in a sample crystal where channels intersect. In the situation we meet in the CF phenomenon, there are occluded deuterons with a constant spacing between them on the channeling axis.

When a neutral particle is generated at an interstitial site, the particle will direct isotopically outward from the site. The interaction of the particle with crystal atoms on the lattice sites makes the direction of the particle along the channeling axis and, in short time, a lot of particles propagate along the channel. Let us consider, for simplicity, that all particles propagate along the channeling axis. Then the particle traveling along the channel makes frequent collisions with occluded deuterons on the interstitial site.

In the process of propagation along the channel, the photon with energy 6.25 MeV interacts with occluded deuterons on the interstitial sites. If the density of the occluded deuteron is near saturation, the deuterons are in periodic array. Then the photon propagating along the axis is Bragg reflected by the deuterons and is trapped on the axis until it disappears disintegrating one of those deuterons.

The photodisintegration cross-section of the deuteron has its maximum at about 5 MeV with the value 2.5 mbarns [18]. Thus, the photon of our concern is most effectively attenuated by the disintegration of deuterons in the CF materials and can not come out easily from the sample. In the case of wet experiments using D_2O, there is heavy water around the sample and the photon attenuates effectively in the water before reaching a detector. This makes it especially difficult to observe 6.25-MeV photons in wet experiments.

In addition to the difficulty of penetration through the crystal because of photodisintegration, the electromagnetic interaction of a photon with ordinary materials is least at this energy range from 1 to 10 MeV. This means that it is difficult to detect photons with these energies with usually employed apparatus. The duplication of these two reasons makes this photon undetected until now, especially in wet experiments using heavy water. Only a few cases where gammas were measured were in the dry experiments.

In the case of 14.1-MeV neutrons, the situation of channeling is similar to the case of the photon [16], though the possible reactions with deuterons are multivalent. The neutron can disintegrate several deuterons until it loses energy to become inactive to the reaction, and can accelerate several deuterons by elastic collisions giving them enough energy to fuse effectively with other deuterons, and can finally fuse with another deuteron by reaction (1) when it becomes sufficiently low energy.

The cross-section of deuteron disintegration by neutrons increases rapidly at 2 to 10 MeV and saturates at about 14 MeV with a value of 0.11 barns [19].

This value is only one order of magnitude smaller than that of elastic collision and four orders of magnitude larger than the absorption cross-section for the same energy. So, the neutron with energy 14.1 MeV in the channel filled with deuterons loses its energy by deuteron disintegration, effectively producing neutrons in the sample. This mechanism has not been taken into consideration explicitly before.

Therefore, the neutron has more difficulty coming out from the sample than the photon considered above though the Bragg reflection of the original neutron by the deuterons on interstitial sites is not so effective compared with the 6.25-MeV photon because of the difference of their dispersion relations.

In addition to the above mentioned situation, detection of 14.1-MeV neutrons needs special attention. The energy of 14.1 MeV is classified as high energy and the interaction cross-sections of neutrons with materials usually used in neutron detectors fall rapidly with energy. The sensitivities of BF_3 and ^{3}He counters decrease rapidly by 10\pref{-4} going from 1 eV to 10 MeV of neutron energy. Proton elastic collision cross-sections also decrease one order of magnitude, going from 2 MeV to 14 MeV.

3. Conclusion

The cold fusion phenomenon is very complicated, generating various products with various characteristics in various materials. It is apt to find out a brand new principle (so-called missing factor) to resolve riddles not known until 1989, and which seem impossible to solve by ordinary physics. The physics we have now is, however, a solid basis of modern science and has a well-made, consistent structure though there remain several ambiguous points in problems of the physics of many-body systems, of systems with organic structure, and of elementary particles. So, it is desirable to keep its form as far as we can use it to understand new phenomena.

The present work is such a trial in understanding the CF phenomenon with the use of ordinary physics, developing the physics of many-body system with neutrons and crystal nuclei not noticed until now. The result given here is not fully quantitative yet but it provides a new perspective for the understanding of the CF phenomenon consistently with other branches of physics.

The nature of CF phenomenon is stochastic in our understanding, and therefore its application for technology will be restricted by this characteristic, especially its uncontrollable reproducibility. It is also noted that the characteristics of the CF phenomenon is deeply related to nuclear reactions, and its application is not free from nuclear products hazardous for life. Protection from radiation in application of CF for a source of energy and of particles, should be a conscious matter.

Quantitative justification of the explanation of CF riddles given above needs statistical and theoretical works in the many-body problem. It should be the future work of scientists in CF.

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Evidence of Neutron Burst in Vanadium-Deuterium System

More Evidence of Cold Fusion Catalyzed by Low-Energy Neutrons

Hideo Kozima
Shizuoka University

Abstract

Experimental results of neutron bursts from vanadium deuteride ($VD_{1.2}$) are analyzed in the Trapped Neutron Catalyzed Model for Cold Fusion (TNCF). It is shown that the experimental result is an indicator of the specific behavior of the low-energy neutrons in solids occluding deuterons.

1. Introduction

It is now decisively recognized that neutron bursts are generated in deuterides of palladium and titanium [1–5], satisfying some specific conditions clarified in cold fusion (CF) research.

On the other hand, an interesting observation of neutron bursts from vanadium deuterides ($VD_{1.2}$) was reported [6] in a document published in Russia. In this experiment, deuterium was fed by gaseous contact, and the generated neutron was measured in thermal cycles between 300° and 673° K. The distribution of the number of pulses in 300 s in the background experiment (Fig. 1) and that of the number of bursts in the same time interval (300 s) observed in the foreground experiment (Fig. 2) were compared. The total number of neutrons in burst in 300 s was $3 \times 10^3 \sim 3 \times 10^6$ when the number of the background neutron pulse was 0.074 x 300 (i.e., the number of neutrons in bursts is $10–10^4$ per second or $1.5 \times 10^2 \sim 1.5 \times 10^5$ per background neutron).

Two distributions with the maxima at 21 pulses and at 22 bursts respectively coincide very well each other as seen in Figs. 1 and 2.

In this paper, we will investigate this data in the TNCF model and show that the data demonstrates a role of low-energy neutrons in CF.

2. The Cold Fusion Phenomenon and Neutron Bursts

The indices of the cold fusion phenomenon are excess heat and nuclear products. Among the nuclear products, neutrons and tritium have been observed most often. There are two features in the generation of neutrons; one is the neutron burst occurring intermittently and including a lot of neutrons in a short time, at most 10^8 per second, and the other is stationary neutron generation.

Stationary neutron generation gives few neutrons in a short time but gives a large number, as a whole, in a long period. On the other hand, the neutron burst gives 10^6 to 10^8 neutrons in a burst last-

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