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LETTER TO THE EDITOR

DEUTERIUM NUCLEAR FUSION IN METALS AT ROOM TEMPERATURE*

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Original scientific paper

An attempt to induce the nuclear fusion in PdD by the electrolysis of heavy water was made. The three compartmental electrolytical cell with control instruments to enforce sorption and desorption of deuterium in palladium was used. The characteristics of the nuclear radiation detector are presented. The pulse height spectra of neutrons were analysed and the upper limit for neutron emission was compared with the background counting rate. No evidence for the d + d fusion reaction was found. The average counting rate limit of neutrons from the foreseen (d, n) reaction was less than 0.0007 counts per second. This number corresponds to the detection limit of one standard deviation.

In 1947 in Great Britain it was observed[1] that cosmic ray mesons gave rise to a 4 MeV secondary meson at the end of their path in a photonuclear emulsion. To explain this phenomena F. C. Frank suggested a hypothetical alternative energy source for the *second meson* event[2]. In the late forties the theory of the catalysed nuclear fusion was suggested in the USSR as well. In 1957, in the USA, Alvarez et al.[3] during the experiment involving the stopping of K mesons observed catalysis of nuclear reaction by negative muons.

A negative muon has properties similar to those of an electron. The Bohr radius of a muon is about 207 times smaller than the radius of an electron. Therefore the probability for the d + d nuclear fusion at room temperature is about 10^{80} times higher for muons than for the ordinary deuterium[4]. A positive energy balance with muonic catalysis in the hybride system was suggested as a possibility[5].

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Recently in Preliminary note Fleischmann and Pons[6] claimed to have had observed electrochemically induced nuclear fusion of deuterium with the positive energy. The enthalpy generation exceeded 10 W per cm^3 of the Pd electrode and an excess of 4 MJ cm^{-3} of the electrode volume was released. There was no evidence for corresponding number of neutrons and tritium.

At the same time Jones et al. published a preprint[7] on cold nuclear fusion in condensed matter. The observed fusion rate was $(4.1 \pm 0.8) \cdot 10^{-1}$ fusion/s.

The electrolytical cell used in the work described consisted of three compartments. The Pd cathode surrounded by a Pt wire anode was placed in the main compartment. During the long term electrolysis it was found that platinum anode dissolved. As a result thin Pt layers were detected on Pd cathode using X-ray fluorescence spectroscopy. In the work of Jones et al.[7] the importance of codeposition of various metals on palladium cathode was pointed out. However, a thin layer of foreign metal deposited on palladium electrode could prevent further absorption of deuterium. Therefore, in the subsequent experiments large Pd sheet was used as an anode. The cup of the main compartment was sealed with parafilm. The potential of the palladium cathode was measured against the reference electrode (saturated calomel electrode).

The ^6Li — glass scintillator (NE 912) counter, similar to the one developed by Kedem and Kedem[8,9] was used for the detection of neutrons. A scintillator of 2 mm thickness was sufficient to obtain 98% efficiency for thermal neutrons, and at the same time showed a low sensitivity for gamma rays. The ^6Li-glass disk of 5.1 cm in diameter was coupled to a photomultiplier using a light guide made of plexiglass. The thickness of the polyethylene moderator (5 cm), which was placed in the front of the scintillator, was chosen so that the optimal number of counts for 2.5 MeV neutrons could be obtained. The 1% efficiency of the detector was determined by placing the ^{252}Cf neutron source in the front of the detector. Fig. 1. shows the spectrum obtained. The ^6Li I (Eu) crystal, which has a very low sensitivity for gamma rays, with or without Bonner sphere, was also at disposal in the laboratory. However, due to its smaller dimensions and consequently its lower neutron efficiency, it was used only as a control monitor.

The experiment was carried out in an underground laboratory having 0.2 m concrete deck covered by 3.0 meters of soil. The electrolysis regimes and electrochemical conditions used in this experiment are published separately[10]. Palladium charging with deuterium was checked by weighing. The typical value of 0.15 g of deuterium per 14 g of palladium was found. The counting rate of the glass scintillator in the neutron peak was 0.15 impulse s^{-1}. After each measurement the ^{252}Cf (neutron source) was used to check the stability of the counting system. The pulse distribution obtained during the electrolysis of heavy water is shown in Fig. 2. The total duration of this experiment was $3 \cdot 10^5$ s. The counting rate for neutrons was 0.01 neutron/s. Table 1 summarizes all the data collected in the pulse height spectrum of Fig. 2. It is evident that there is no significant deviation of the counting rate of each particular measurement from the average value of 0.1519 ± 0.0007 per second. The difference between the pulse neutron spectra obtained with and without D_2O electrolysis is shown in Fig. 3. This proves that no significant excess of neutrons above the background level could have been observed even during shorter periods of time.

The measurements of tritium concentration in the electrolyte and from palladium electrodes, using the liquid scintillation counter are in progress. An attempt

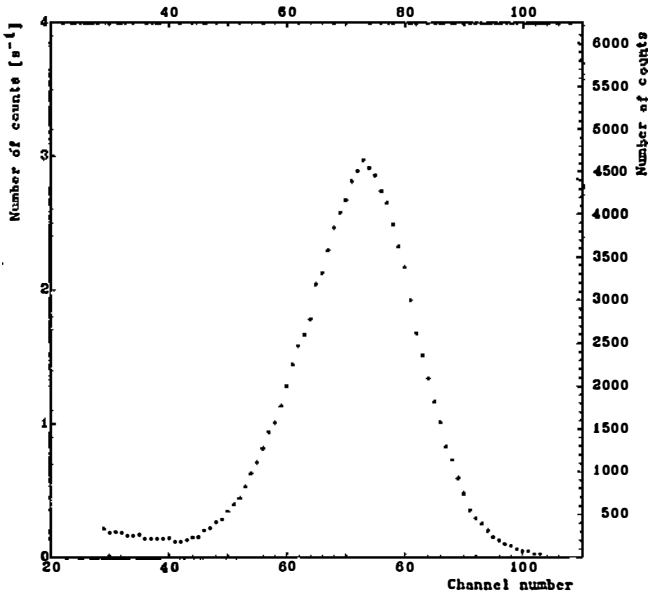

Fig. 1. Pulse-height spectrum of ^{252}Cf fission neutron source.

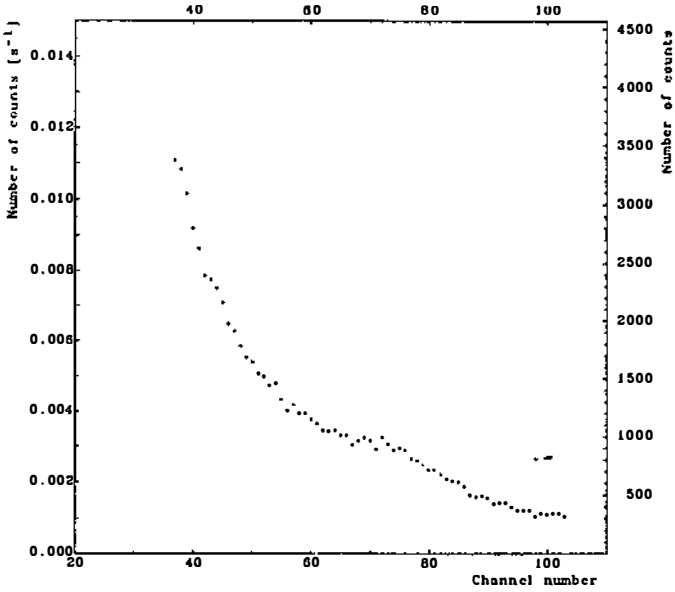

Fig. 2. Pulse-height spectrum accumulated during electrolysis of Pd electrode; total time = 304700 s.

TABLE 1.

	t_i/s	N_i	(N_i/t_i)/s	$D = \Sigma N_i/\Sigma T_i - N_i/T_i$
1.	20795	3204 ± 57	0.1541 ± 0.0027	0.0022 ± 0.0027
2.	18000	2699 ± 52	0.1499 ± 0.0029	0.0020 ± 0.0029
3.	39000	5909 ± 77	0.1515 ± 0.0020	0.0004 ± 0.0020
4.	39000	5947 ± 77	0.1525 ± 0.0020	0.0006 ± 0.0020
5.	39000	5920 ± 77	0.1518 ± 0.0020	0.0001 ± 0.0020
6.	27000	4039 ± 64	0.1496 ± 0.0024	0.0023 ± 0.0024
7.	39000	6049 ± 77	0.1551 ± 0.0020	0.0032 ± 0.0020
8.	39000	5931 ± 77	0.1521 ± 0.0020	0.0002 ± 0.0020
9.	44000	6596 ± 81	0.1499 ± 0.0018	0.0020 ∓ 0.0018
	304700*	46294 ± 215*	0.1519 ± 0.0007**	

t_i — duration of measurement
N_i — number of counts in the region of neutron peaks
N_i/t_i — counting rate with statistical errors
D — deviation from the average counting rate
* — total
** — average counting rate

Data for some typical measurements.

will be made to detect protons from (d, p) reaction in order to make a comparison with the results of tritium concentration measurement.

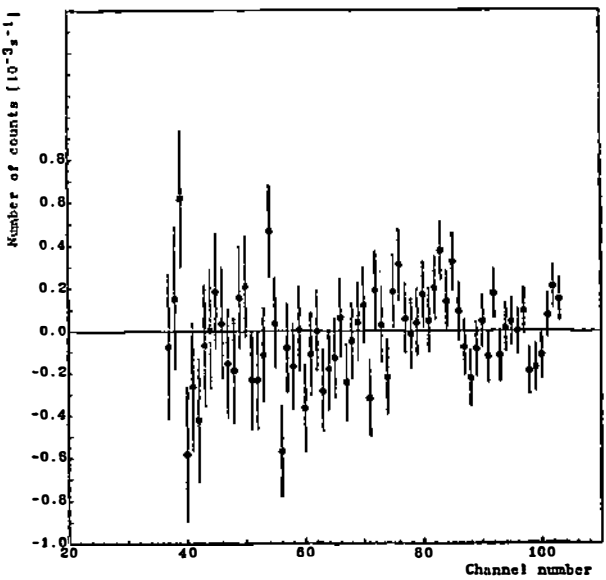

Fig. 3. Same as Fig. 2.: background subtracted.

Acknowledgement

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NUKLEARNA FUZIJA DEUTERIJA NA SOBNOJ TEMPERATURI

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Istraživana je mogućnost nuklearne fuzije deuterija u paladiju pri elektrolizi teške vode. Korištena je elektrolitička ćelija u tri dijela s uređajima za kontroliranu sorpciju/desorpciju deuterija. Opisane su karakteristike uređaja za detekciju neutrona koji se sastoji iz brojača visoke efikasnosti. Ustanovljena je granica od 0.0007 impulsa/s. Dobiveni rezultati pokazuju da je emisija neutrona iz proučavanog procesa unutar razine prirodnog zračenja.