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TIME-CORRELATED NEUTRON DETECTION FROM DEUTERIUM LOADED PALLADIUM

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Abstract: Significant neutron bursts and good time-correlation between two independent neutron detection systems were observed in two kinds of experiments on cold fusion. One employed two palladium rods of 2 mm diameter and 5 cm length, deuterated under 1 atm for 30 days, and plasma discharge was applied as a trigger. The other was palladium shavings of 10 g deuterated under 11 atm for 40 days. The averaged background level was 5-6 counts/dwell time (100 s). In both cases, significant neutron emission of successive bursts of 13-60 counts/100 s were observed for several hours and repeated several times during 2-11 days in some cases.

INTRODUCTION

Since firstly reported on cold fusion[1,2], most of gas phase experiments employed titanium[3,4] and not much is reported on neutron emission due to the cold fusion from deuterium gas loaded palladium. In the case without any shielding of cosmic ray background, studies were made to generate large neutron bursts from deuterium gas loaded palladium.

It is widely believed that the reduction of neutron background levels is critical, however as shown in the present paper, one can observe large neutron bursts if a dwell time is properly chosen. In a too long case, those rare bursts are buried in the background level, which may lead to conclude lower background level. In a too short case, those bursts are decomposed into frequent one- or two- neutron events like random emission.

EXPERIMENTAL SET-UP

Figure 1 shows an experimental set-up. We tested two kinds of experiments. One(Exp.I) employed two palladium rods of 2 mm diameter and 3 cm length facing each other located in a glass chamber of 500 cc volume. The chamber was initially filled with deuterium gas of 1 atm

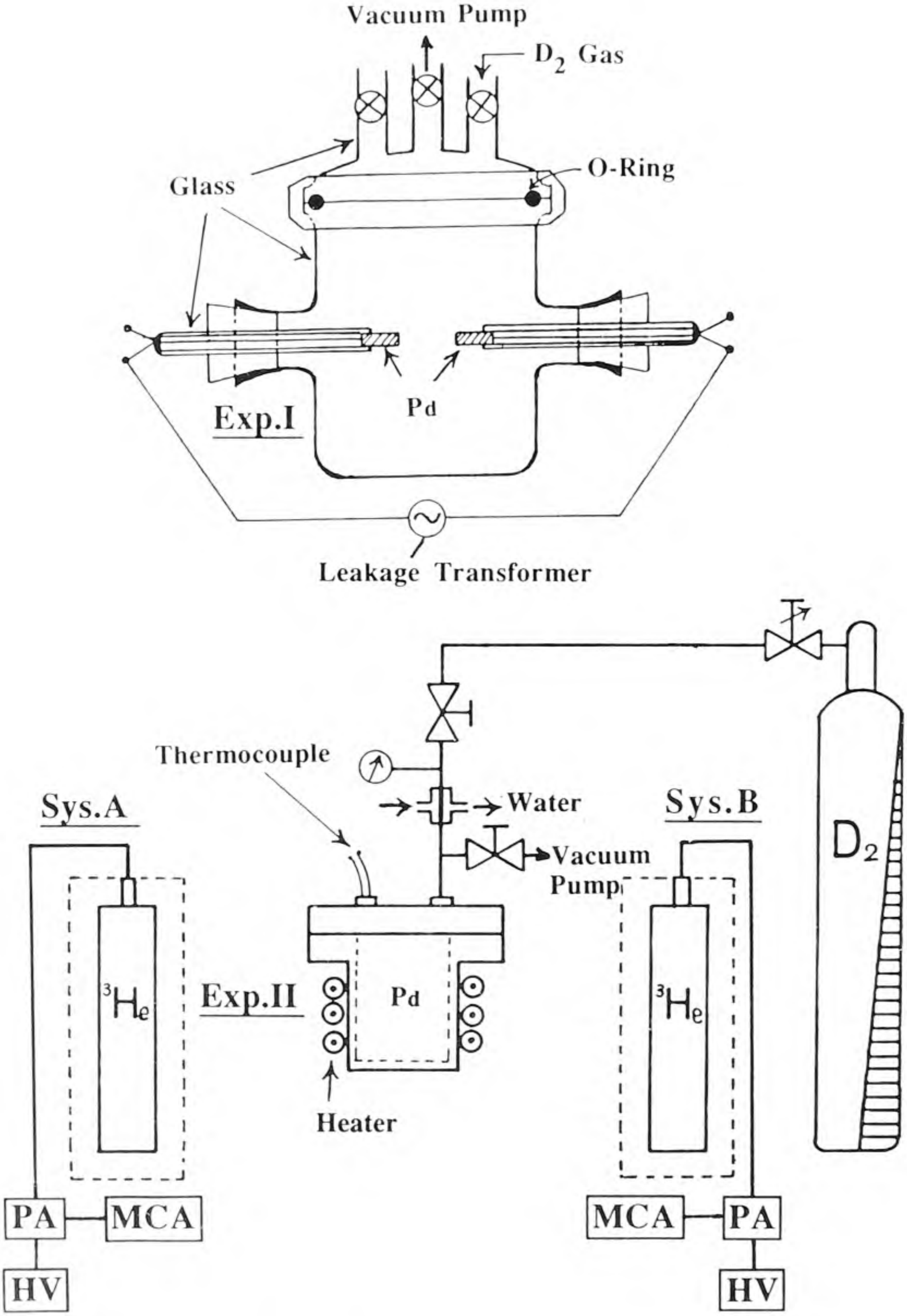

Fig.1 Experimental Set-up.

pressure which was reduced down to 0.54 atm after 30 days with absorption of deuterium into palladium. The estimated ratio of deuterium atoms to palladium atoms was 0.92. We applied AC plasma discharge two times for 5 min.(60 Hz, max.15 kV, max.20 mA) as a trigger for the cold fusion[5].

The other(Exp.II) employed palladium shavings of 10 g weight in a small ss chamber, of which thickness, width, and length were ≈0.3 mm , ≈1. 3 mm, and 3-6 cm, respectively. Deuterium gas of 11 atm pressure was mainly filled but many thermal cycles were tried to activate palladium surface for 40 days. The typical cycle after activation was as follows, i.e.

11 atm -> evacuation(≈10^{-2} Torr) -> 11 atm(max.40 °C up)
-> 5.7 atm after 2 hrs -> 11 atm -> 9.3 atm after 10 hrs
-> evacuation(≈10^{-2} Torr)

We thought above final evacuation was the trigger for the cold fusion.

In order to confirm that signals are originated from the deuterated palladium, two independent sets of neutron counter employing ^{3}He tubes, were located to check time-correlation between the bursts detected by these counters. We called these as Sys.A and Sys.B. The tube of Sys.A had 5 cm diameter, 40 cm length, and 8 atm pressure, and that of Sys.B had 2.5 cm diameter, 30 cm length, and 9.9 atm pressure. Both were housed in paraffin moderators. The respective distances from the center of the chamber were 25 cm and 22 cm, so that efficiencies were approximately 1 % and 0.5 % when calibrated by ^{252}Cf. The pulse height windows were set at best to eliminate spurious signals. The dwell time was 100 sec in most of the cases. The counts were recorded in each multi-channel analyzer.

EXPERIMENTAL RESULTS

Figure 2 shows neutron counts in Exp.I. No neutron burst had been observed during deuterium loading and discharge phase, but first group of neutron burst was observed 2 days after the discharge. Three groups of successive bursts appeared during 11 days after the discharge.

We can see good time-correlation between the neutron bursts detected by Sys.A and Sys.B. Since the ratio of signal levels of Sys.A to those of Sys.B corresponds to that of each efficiency, signal should be originated from deutrated palldium.

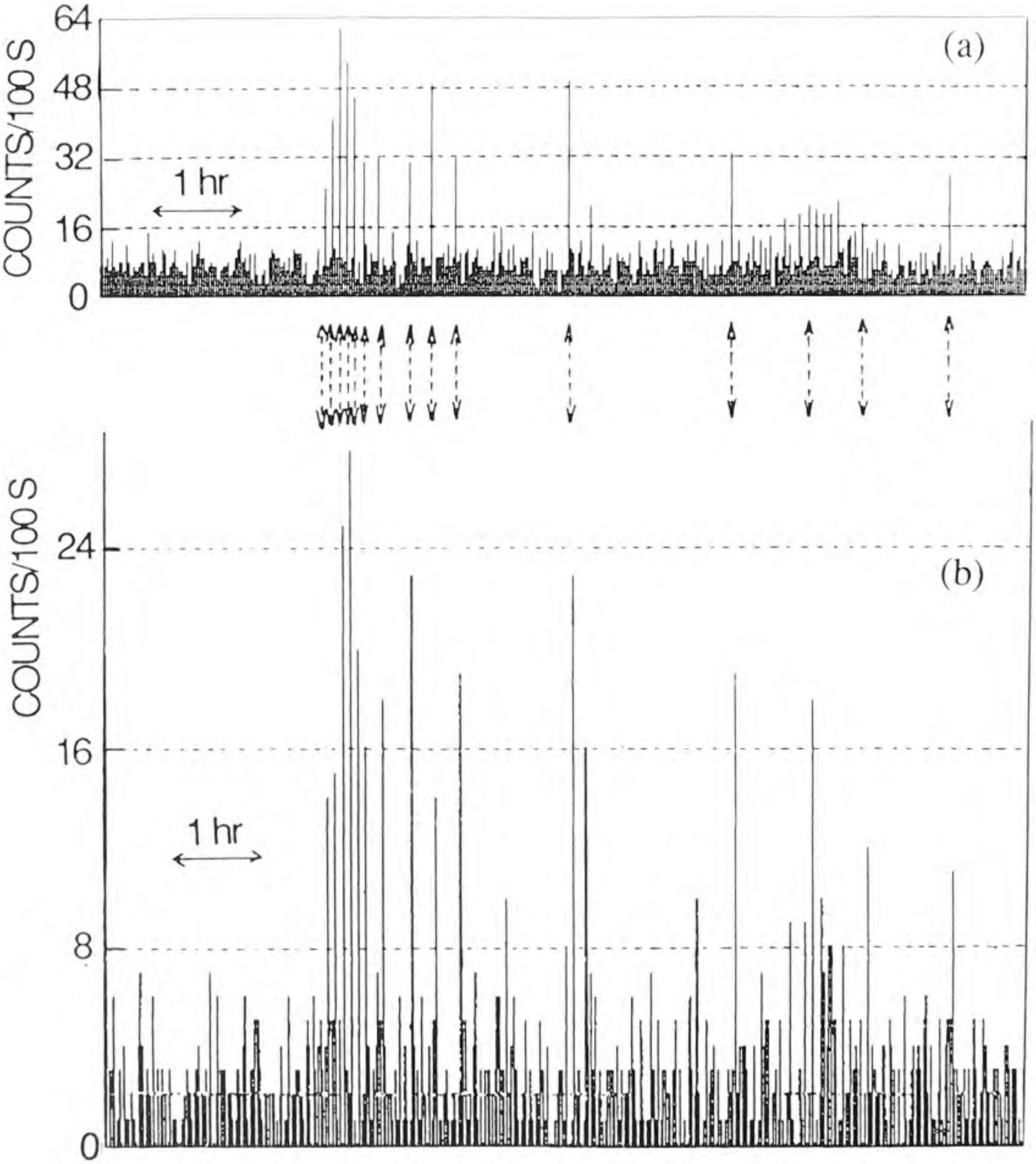

Fig.2 Neutron Bursts in Exp.I(6-8 Spt.1990) Measured with (a)Sys.A and (b)Sys.B

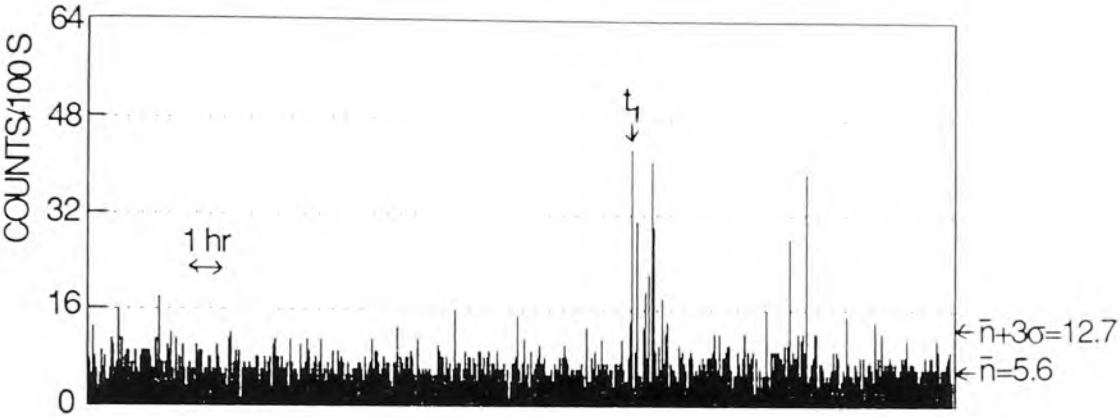

Fig.3(a) Neutron Bursts in Exp.II Measured with Sys.A(4-5 Feb.1991).

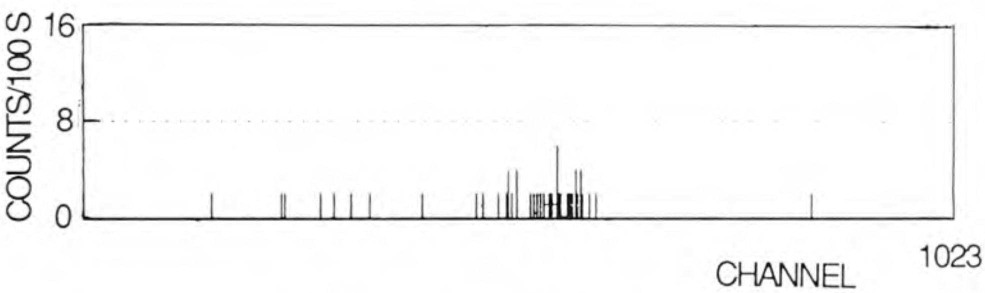

Fig.3(b) PHA at time t_1 in Fig.3(a).

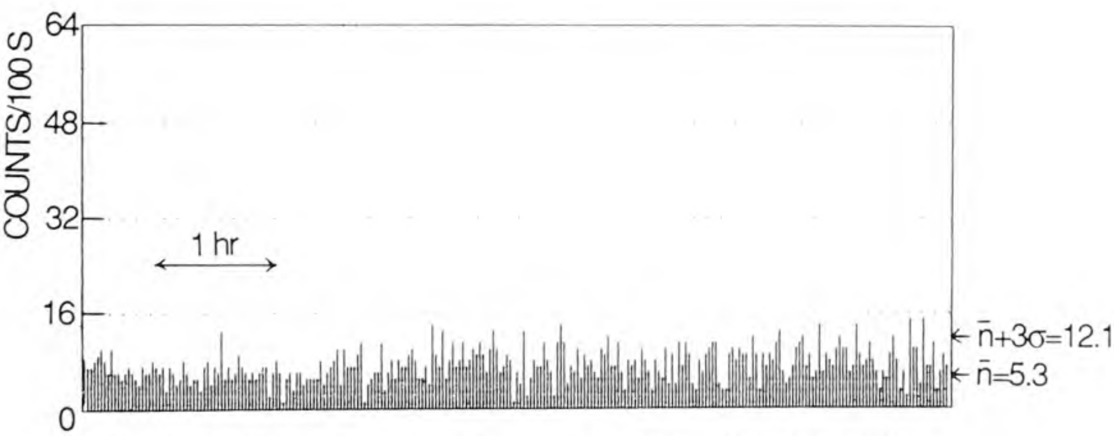

Fig.4 Background Signals Measured with Sys.A(7 Feb.1991).

In Exp.II first group of the neutron bursts appeared within one hour after evacuating started as shown in Figure 3(a). The neutron bursts of 24 channels had been observed among 2000 channels of MCS(i.e. 54 hours). The maximum count was 42 when an average count $\bar{n}$ was 5.6 and $\bar{n}+3\sigma$ =12.7.

Figure 3(b) shows a typical PHA at the time of the maximum count of MCS. Most of pulses was caused by neutrons thermalized in the paraffin moderators surrounding the ^{3}He tube.

Two days after the experiment, we checked the background level as shown in Fig.4. The average count $\bar{n}$ was 5.3 and $\bar{n}+3\sigma$ =12.1.

CONCLUSIONS

(1) Even in the case of no shielding to reduce the background of which level was 5-6 counts/100 s, large neutron bursts of 13-60 counts/100 s from deuterium gas loaded palladium were detected when the neutron detector of 1 % efficiency was employed.

(2) The neutron bursts were composed of many short time bursts, so that MCS spectrum will change drastically with the chosen dwell time.

(3) Although many groups of the bursts lasting for 2-11 days were observed, no burst had been observed during triggering (plasma discharge or evacuating) and gas loading phases.

(4) The neutron bursts were reasonably time-correlated between the two independent detection systems, so that it is hardly conceivable that those signals were originated from some spurious sources.

(5) Mechanism of the cold fusion and major parameters to produce neutron are still open question, but in our case high deuterium concentration might be needed, for example the ratio of deuterium atoms to palladium ones should be higher than 0.9, and cold-worked palladium might be essential to attain such high ratio.

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