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SEARCH FOR PRECURSOR AND CHARGED PARTICLES IN "COLD FUSION"

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I. Introduction

After two years the puzzle of nuclear phenomena in a metal lattice (cold fusion) is still with us. Excess heat [1], or anomalous neutron emission [2] was the goal being searched in most of the "cold fusion" experiments, however, we switched to search the precursor and the energetic charged particles in stead of excess heat or anomalous neutron emission. In fact, we started the electrolysis cell experiment early in April, 1989; the neutron bursts were detected by BF_3 detector, and the tritium was measured by liquid scintillation detector [3]. The sporadic nature of the signals and the difficulties in reproducing these signals forced us to look for a new approach in identifying this anomalous nuclear effect.

We suggested [4] that the energetic charged particles are necessary products for any anomalous nuclear effect, since after the reaction of any two charged nuclei there must be at least one charged product. In contrary, the neutron may not be the necessary product.

Besides, we believe that there must be some precursors before the anomalous nuclear effects. Once the precursor is identified, the difficulty in reproducing these sporadic signals would be reduced. We suggested that the electromagnetic radiation is a possible candidate for precursor, since the charged particles must change their states before the penetration of the coulomb barrier becomes feasible. The energy of this electromagnetic radiation has been estimated to be the order of keV; therefore, it is quite different from the electromagnetic radiation caused by fusion product, which is in the range of hard X ray or Gamma radiation. The

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Frascati type experiment [5], led by Prof. Scaramuzzi, is particularly suitable for the detection of energetic charged particles and the low energy electromagnetic radiation, since there is no electrolyte to hinder the measurements. The plastic track detector (CR−39) and thermoluminescence detector (TLD) were proposed to detect the energetic charged particle and the low energy electromagnetic radiation [4]. The preliminary run of experiments showed positive results [6]; however, the abovementioned detectors are of integrated nature. It is desirable to measure the signals in real time sequence, then it would be more confident to identify the "precursor".

Au−Si surface barrier detector is suggested to do this real time measurement, because it is sensitive to both energetic charged particles and electromagnetic radiations, and it has comparable sensitivity as CR−39 does. In this note the preliminary results of measurement will be presented.

Ⅱ. Experimental Arrangement

Fig.1 is a schematic diagram of the experiment system. The degassed palladium and titanium foils were sealed in a stainless steel vessel, facing the Au−Si surface barrier detector in a close−up way. This vessel was connected to a pressurized deuterium storage of 2 atm. Before this connection the vessel was pumped out by a mechanical pump for half an hour. After the connection the vessel was immersed in a liquid nitrogen dewar to let deuterium absorbed into palladium and titanium foils. When the system was cooled down and reached steady state, the valve was closed and the liquid nitrogen dewar was taken away. The system warmed up to room temperature, then this temperature cycle ran again.

Fig.2 shows the block diagram for electronic circuits, which was designed particularly for detection of both electromagnetic radiation and energetic charged particles, for detection of both single signal and the burst of signals. The low energy channels in the multiple channel analyzer (MCA) correspond to the electronic noise and the electromagnetic radiations. With careful setting of discriminator we could still detect part of the electromagnetic radiation in the vicinity of noisy background. The high energy channels in MCA could detect the single signal up to 12.5 MeV. If a burst of high energy charged particle came in a very shot period, the single channel analyzer (SCA) would definitely record it although the MCA might lose it.

Particular attention was paid to avoid any false signals due to the moisture near the cryostat system, and it was successful.

Ⅲ. Results

Fig.3 shows the result of the measurement of background using MCA, we could not see any signals there except in the low energy channels (dotted line). Fig.4 is the result of calibration using a ^{239}Pu α−source ($E_\alpha = 5.1$ MeV). Fig.5 is

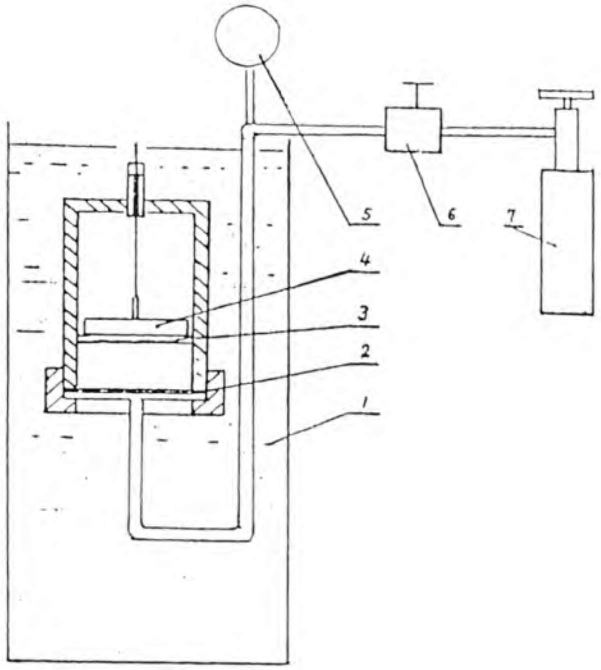

Fig.1 Schematic Diagram of Experiment System
1. LN_2 2. Sealing Spacer 3. Pd, Ti foils
4. Detector 5. Manometer 6. Valve 7. D_2

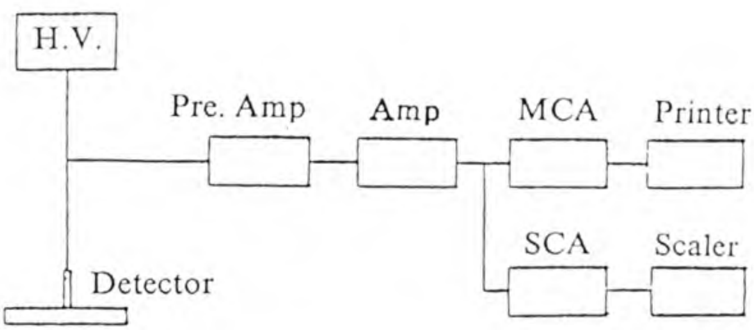

Fig.2 Block Diagram of Electronic Circuits

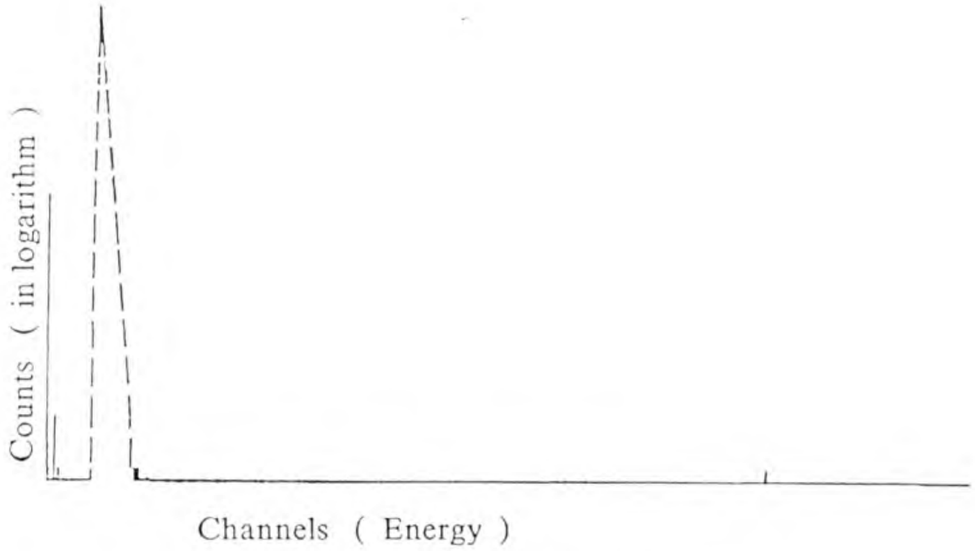

Fig.3 Background

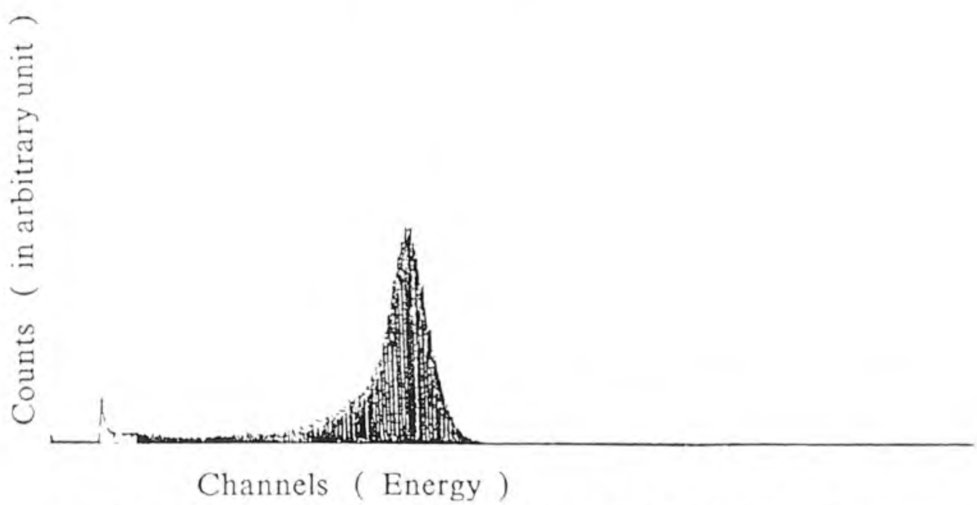

Fig.4 Curve for calibration (^{239}Pu 5.15 MeV α – source)

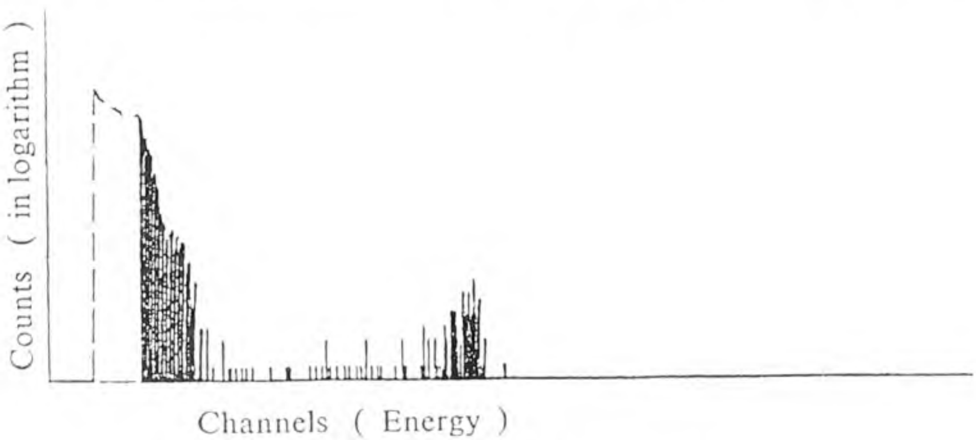

Fig.5 Signals in warming up period

the result for a typical run in the warming up period. The high energy peak corresponds to energy greater than 5 MeV, and the peak accumulated slowly in one hour. In contrast, the signals in the low energy channels, which is just above the electronic noise channel (dotted line), appeared in a very shot period (the rate is about hundred counts in one second). It might be caused by some electromagnetic radiations, since we reproduced similar signals in the similar channels by simply shinning visible light on the same Au–Si detector.

These phenomena were reproduced once and once again in the temperature cycles. Some times the single channel analyzer obtained more than 20–90 counts as well.

The titanium foil was from the titanium shaving, and the palladium foil was cut from the product of Johnson and Matthey Inc. (thickness 25μ). Both of them were friendly given by American scientist.

Ⅳ. Discussion

It is clear that the energy of charged particle has a peak above the 5 MeV. It does not fit with any conventional binary D–D reaction. Although the extraordinary branch, D+D→ ^{4}He+23.8 MeV, might give more energy, we had to assume an anomalous branching ratio. It is suggestive to use dE / dx detector for identification of the charged particles.

If we assume that the low energy signals were caused by electromagnetic radiation, this was a good manifestation of precursor. We planned to use photo–electric diode for confirmation of this observation. Was there any mistake which might cause the fault signals? We were worried about this also. A good verification was that we did not detected any signals as before when the vessel sealing failed in one of the experiments.

Ⅴ. Acknowledgements

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