Correlated neutron and acoustic emission from a deuterium-saturated palladium target

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In experiments carried out in a low-background underground laboratory, 42 events of neutron and acoustic emission correlated within 100 μs were observed as a palladium sample became saturated with deuterium. The number of random events expected was six. These results correspond to the predictions of the acceleration model of cold fusion, according to which neutrons are produced in the collision of deuterons accelerated in microfissures formed during the cracking of a deuterium-saturated palladium sample.

Experiments have been carried out in the low-background underground Baksan laboratory,[2] at a depth of 10^3 meters water equivalent, in an effort to test the results of Ref. 1 that there is a temporal correlation between the pulses of nuclear and acoustic emission during electrolytic saturation of palladium with deuterium. Low-background shielding made it possible to lower the γ-ray background (in the energy range 0.2–3.0 MeV) by a factor of 200 even without the use of special structural materials for the installation. The background of isolated thermal neutrons was lowered by a factor of about 30. A grounded aluminum wall shielded against electromagnetic interference, as did the metal housing of the low-background chamber itself.

The palladium sample, with a purity of 99.9%, dimensions of $2.5 \times 5 \times 56$ mm, a mass of 10 g, and a surface area of 2.5 cm^2, was saturated with deuterium in an open electrolyzer with a solution of $LiClO_4$ (0.1M) in 20 ml of D_2O (Fig. 1). To detect the neutrons from the $d,d \rightarrow {}^3He,n$ reaction after their moderation in paraffin, we used ten SNM-18 counters. The neutron detection efficiency $\eta \simeq 10\%$ was measured by replacing the sample by Pu–Be and ^{252}Cf neutron sources. A UTS-19 ceramic piezoelectric washer, 5 mm in diameter and 1 mm thick, soldered to the upper part of the palladium cathode (5 mm above the electrolyte level), detected the acoustic signals with a bandwidth < 1 MHz. The information on the neutron and acoustic channels was fed to an oscilloscope, whose sweep was triggered by the pulse from the neutron detectors, and also to counting circuits.

According to the acceleration model,[3] an acoustic pulse should correspond to each neutron pulse (but not vice versa), since neutrons appear in collisions of deuterons which are accelerated in the electric field created by the charge formed during the cracking of the deuterium-saturated palladium sample. The difference Δt between the times at which the neutron pulse and the acoustic pulse are detected is determined by the scatter in the neutron moderation times $t_{\rm mod}$ and in the times $t_{\rm ac}$, taken by the

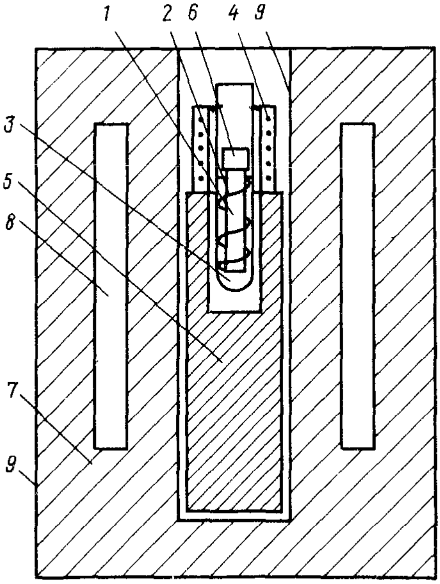

FIG. 1. Experimental layout. 1—Pd cathode; 2—Pt anode; 3—electrolyte; 4—temperature regulation unit; 5—central paraffin block; 6—acoustic pickup; 7—moderator (polyethylene, paraffin); 8—SNM-18 slow-neutron counters (there are ten such counters); 9—shielding containers.

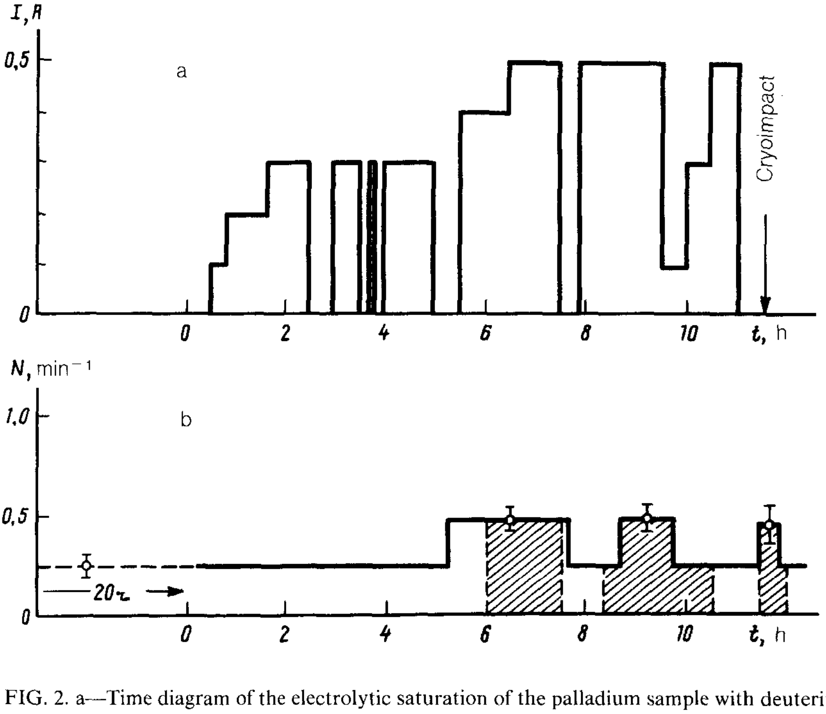

FIG. 2. a—Time diagram of the electrolytic saturation of the palladium sample with deuterium; b—intensity of the emission of isolated neutrons from the saturated sample (the hatched regions correspond to the correlation measurements).

acoustic signal to propagate along the sample: $\Delta t = t_{ac} - t_{mod}$. In our experiments, the values of Δt were measured on the oscilloscope screen, where a standardized acoustic signal and an acoustic signal shifted 100 $\mu s > |\Delta t|$ were displayed. The initial amplitude of the latter signal exceeded a specified threshold set on the basis of the acoustic noise.

The total duration of the experiment was 8.5 h, and the current density in the electrolyzer was 10–60 mA/cm^2. Correlation measurements were carried out for 3.5 h (Fig. 2). About 5 h after the current was turned on, we observed an increase in the neutron count rate to a level twice the background level. We then observed the neutron emission which has been observed previously[4] during quenching of the sample in liquid nitrogen ("cryoimpact"). A total of 42 events with a temporal correlation within 100 μs of the signals from the slow-neutron counters and the acoustic pickup, with $\Delta t < 0$, were observed during the measurements (Fig. 3a). The calculated number of random correlations of this sort with $\Delta t < 0$ (or $\Delta t > 0$), at count rates of 0.005 s^{-1} and 800 s^{-1} in the neutron and acoustic channels, respectively, is six events over 4 h of measurements.

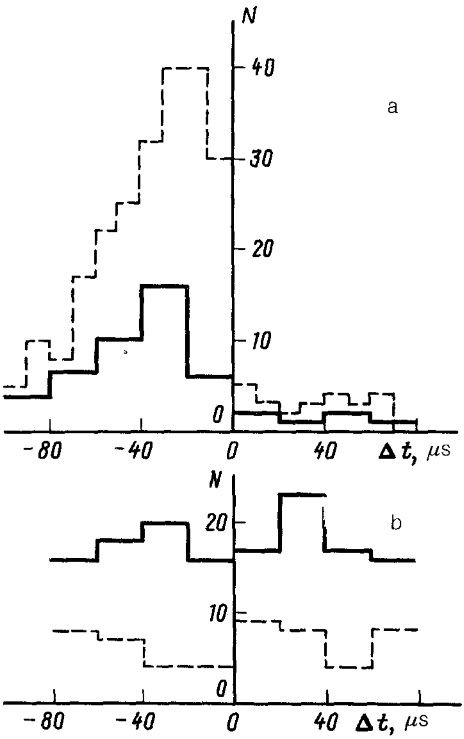

FIG. 3. a—Temporal distribution of the correlated events detected during periods in which the target was in the "active" state (solid histogram) and distribution of the moderation time of neutrons from a ^{252}Cf source installed in place of the palladium cathode (the dashed histogram); b—distribution of uncorrelated events during triggering of the apparatus by a neutron from a ^{252}Cf source (solid histogram) and during "manual" triggering (dashed histogram).

An important characteristic of the correlated events is their distribution with respect to Δt (the solid histogram in Fig. 3a), which reproduces the distribution with respect to moderation time (the dashed line in Fig. 3a) of neutrons from a ^{252}Cf source positioned in place of the palladium cathode. (In the latter case, the central part of the paraffin block was replaced by a scintillation counter with an organic scintillator, so that a given neutron could be detected twice: before and after its moderation.)

In the control experiments the oscilloscope sweep was triggered either "manually" or by a thermal neutron (from a ^{252}Cf source) not genetically related to the acoustic signal. The results of these control experiments are distributed more or less uniformly over all intervals $|\Delta t| < 100\ \mu s$ (Fig. 3b). Most of the events with $\Delta t > 0$ in Fig. 3a correspond to background events. The correlated events correspond to periods of an elevated overall neutron activity of the sample, associated with a change in its state. In summary, the experimental results show that (1) the emission of neutrons by a palladium target occurs in a certain stage of the process in which the sample becomes saturated with deuterium and (2) temporal correlations are observed in the neutron and acoustic emission. These conclusions agree with the acceleration model for cold fusion, in which the acoustic signal that arises upon the opening of a crack in a sample which swells as it becomes saturated with deuterium is associated within a few microseconds with the appearance of a neutron.[3]

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