Comment on "Nuclear Emissions During Self-Nucleated Acoustic Cavitation"

In a recent Letter [1], Taleyarkhan *et al.*, using three independent neutron detectors, claim that self-nucleated acoustic cavitation in a deuterated benzene-acetone mixture (DBAM) generates neutrons at the rate of $5 \times 10^3-10^4$ n/s. The purpose of this Comment is to show that at least for measurements with scintillation Li-based thermal neutron (TND) (see Ref. [2]) and CR-39 track detectors the neutron signature is significantly lower than Taleyarkhan *et al.* claim and provides no clear statistical evidence of neutron emission.

(i) Let us first consider the results for TND via the supplemental information [3]. As expected for a scintillation solid-state neutron counter, the amplitude spectrum of Pu-Be neutron source (Fig. 2 of Ref. [3]) shows a large peak (~95% of all counts) approximately between the 33rd and 48th channels, reflecting energy deposition caused by neutron capture in Li⁶. The "tail" below the 30th channel (containing $\sim 5\%$ of total counts) usually suggests not only gammas, but also includes the entire lower pulse height electromagnetic noise. This is especially critical for Ref. [1], where the foreground counts are collected during cavitation turn-on (generating electromagnetic noise), whereas the background is detected during cavitation turn-off (no electromagnetic noise). That is why the efficiency of TND should be corrected in the area of the neutron peak (Fig. 2 of Ref. [2]), giving $\varepsilon_n = 1.23 \times$ 10^{-5} . The rate of neutron emission during cavitation turn-on can be estimated by neglecting the tail below the line separating "gamma" and neutron counts [Figs. 4(a) and 4(b) of Ref. [3]]. Thus, the number of foreground and background counts would be $N_f = 33$ and $N_b = 11$, respectively. The neutron yield during a run with duration $\tau = 3600$ s can be derived from a simple statistical consideration [4]: $I_n = 496 \pm 150$ n/s in 4π sr, with a confidential level of 3.3σ . Note that the tail below the 30th channel cannot be ascribed to gammas caused by neutron absorption. In that case, the similar tail would also appear in calibration runs (Fig. 2 of Ref. [3]).

(ii) To analyze CR-39 track detector results we consider the foreground (DBAM, cavitation on) and the background (cavitation off) runs. Note that the background cannot be ignored in this work because measurement in [3] involves all tracks, not only the specific proton recoil from fast neutrons. Hence, a portion of background tracks during cavitation on/off may represent a buildup of the environmental alpha nuclides inside the setup. By taking into account calibration data (line 13 of Table II [3]) and the geometrical factors (Fig. 1 of Ref. [3]), the CR-39 efficiency to fast neutrons related to the 3–14 h etch is found to be $\varepsilon_n \approx (0.25-1.0) \times 10^{-6}$. Averaging CR-39 data, in lines 4 and 5 from the top of Table II [3] (batch 1, 3 h etch), and taking into account the detection efficiency $\varepsilon =$ 2.5×10^{-7} , the neutron emission rate above the background is estimated as $\langle I_n \rangle = (6.8 \pm 2.4) \times 10^3 \text{ n/s}$ in 4π sr with a confidential level of 2.8σ . The other two runs related to the 3 h etch (batch 2, lines 11 and 12 from the top of Table II [3]) show $\langle I_n \rangle = (5.2 \pm 2.8) \times 10^3 \text{ n/s}$ with a significance of 1.9σ . A similar neutron rate can be derived for the batch 1 CR-39 of 14 h etch (detection efficiency $\varepsilon = 1.0 \times 10^{-6}$). The data (in line 8 of Table II [3]) give $I_n = (5.6 \pm 2.4) \times 10^3 \text{ n/s}$ with a significance of 2.3σ .

We were unable to analyze NE-213 results because the neutron calibration data for the geometry used (Fig. 1 of Ref. [3]) were unavailable. However, in both CR-39 and TND runs using DBAM, the neutron emission rate was only in the range 5×10^2 – 5×10^3 n/s with a statistical significance between 1 and 3 standard deviations.

In conclusion, the TND and the CR-39 results by Taleyarkhan *et al.* [1,3] do not present clear evidence of neutron emission during self-nucleated acoustic cavitation. Furthermore, even if weak neutron emission were observed during cavitation, no supporting evidence indicates that a high temperature thermonuclear process was occurring in the imploded bubble. The weak neutron emission during acoustic cavitation in deuterated dielectric liquids observed earlier [5,6] can also be interpreted in terms of deuteron acceleration (up to the keV range), due to an electrical breakdown, as a result of charge separation at the walls of the cavitation bubbles [6]. In order to clarify the thermonuclear origin of the penetrating radiation during cavitation, high efficiency neutron and spectral soft x-ray measurements are required.

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