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 5×10^3–10^4 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 Li^6. The "tail" below the 30th channel (containing ~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 $\varepsilon_n \approx (0.25\text{–}1.0) \times 10^{-6}$. 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 $\varepsilon = 2.5 \times 10^{-7}$, the neutron emission rate above the background is estimated as $\langle I_n \rangle = (6.8 \pm 2.4) \times 10^3$ 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 $\langle I_n \rangle = (5.2 \pm 2.8) \times 10^3$ 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 $I_n = (5.6 \pm 2.4) \times 10^3$ 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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