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

In a recent Letter [1], Taleyarkhan and coauthors claim to observe DD fusion produced by acoustic cavitation. Among other evidence, they provide a proton recoil spectrum that they interpret as arising from 2.45 MeV DD fusion neutrons. My analysis concludes the spectrum is inconsistent with 2.45 MeV neutrons, cosmic background, or a ²³⁹PuBe source, but it is consistent with a ²⁵²Cf source.

Figure 1(a) shows the detector's pulse height spectra of two calibration γ sources, as extracted from Fig. 8 of the Letter's supplement [2]. I use GEANT4 [3] to simulate the detector's electron recoil spectra, which are then convolved with a gaussian resolution function and scaled to fit the measured spectra [4]. The two fits, showing excellent agreement with the data, validate the method and provide parameters for the detector's light output function $L = c (E - E_0)$ and resolution [5] $\eta^2 = \alpha + \beta/E$.

As described in the supplementary methods [6], I simulate proton recoil spectra for the four separate cases. In the two limiting cases of 2.45 MeV neutron emission—no shielding and heavy shielding—the detector is placed 30 cm from the quartz flask containing the cavitation fluid. The two radioisotope simulations assume there are no intervening scattering materials. These techniques were used to accurately model a DD fusion proton recoil spectrum in Ref. [7].

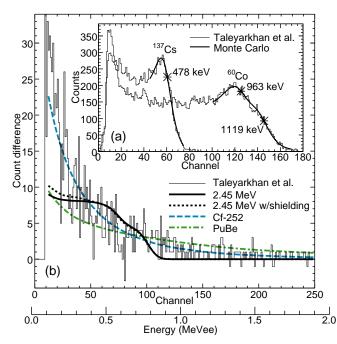


FIG. 1: (color online) Analysis of Taleyarkhan and coauthors' liquid scintillator data. (a) Fitting the measured Compton edges of calibration γ sources to simulated electron recoil spectra determines the detector's energy scale and resolution. (b) Simulated proton recoil spectra of various candidate neutron sources shown fit to data.

Figure 1(b) shows the simulated spectra, fit to data extracted from Fig. 4 of the Letter. As described in the supplementary

methods, the fit is performed simultaneously over the raw cavitation 'on' and cavitation 'off' data, extracted from Fig. 9(b) of the supplement. The $\chi^2_{\lambda,p}$ variable of Ref. [8] determines both the best fit parameters and the goodness-of-fit.

The fit results, summarized in Table I, show the data are statistically consistent with 252 Cf, since the observed value of $\chi^2_{\lambda,p}$ is within one standard deviation of the mean. In contrast, the observed values of $\chi^2_{\lambda,p}$ for the remaining cases are more than five standard deviations beyond the mean, and, consequently, the data are statistically inconsistent with DD fusion or a PuBe source.

TABLE I: Results of fit to simulation. For each fit, numerical sampling determines the distribution of goodness-of-fit variable $\chi^2_{\lambda,p}$. Then, the number of standard deviations from the mean for the observed value of $\chi^2_{\lambda,p}$ is reported as a Z-value. See Ref. [6] for details.

	$\chi^2_{\lambda,p}$	Z-value	
2.45 MeV	653	5.9	
2.45 MeV w/ shielding	637	5.5	
Cf-252	432	-0.45	
PuBe	621	5.9	

Comparing the shapes of the spectra in Fig. 9(b) of Ref. [2] rules out the possibility of cavitation 'on' runs being longer than cavitation 'off' runs. Calling channels ten and below the 'peak' and channels eleven and above the 'tail', the ratio of tail to peak counts with cavitation off is 291/764 = 0.38. When cavitation is on, the tail becomes more pronounced so that the ratio is 1216/835 = 1.5.

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