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

In a recent Letter[1], Taleyarkhan and coworkers 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, and a ^{239}PuBe source, but it is consistent with a ^{252}Cf source.

Fig. 1a shows the detector's pulse height spectra of two γ calibration sources, as extracted from Fig. 8 of the Letter's supplement[2]. Using GEANT4[3] to simulate photon and electron transport, I calculate the electron recoil spectrum, which I then convolve with a gaussian and scale to fit the measured spectrum[4]. The two fits provide the parameters for the light output function $L = c\,(E - E_0)$, and the resolution function[5] $\eta^2 = \alpha + \beta/E$.

Fig. 1b shows simulated[3] proton spectra fit to data extracted from Fig. 4 of the Letter. I convert the energy deposited by proton recoil to equivalent electron energy[6], smear the equivalent electron energy according to the resolution function, and then convert the smeared response to channel number using the light output function. These techniques were used to accurately predict a DD fusion proton recoil spectrum in Ref. [7].

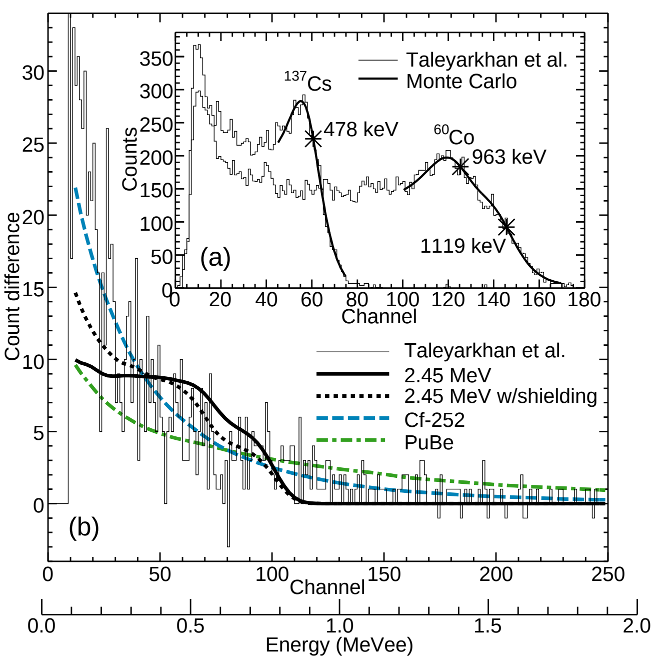

FIG. 1: (color online) Analysis of Taleyarkhan and coworkers' liquid scintillator data. (a) Fitting the measured Compton edges of γ calibration sources to simulated electron recoil spectra determines the detector's energy scale and resolution. (b) Simulated proton recoil spectra of various candidate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

I perform the fit simultaneously over raw cavitation 'on' and cavitation 'off' bins, as extracted from Fig. 9b of the supplement. The theoretical 'off' curve is a double exponential, and the theoretical 'on' curve is the sum of the double exponential and the vertically scaled Monte Carlo proton recoil spectrum. I use the $\chi^2_{\lambda,p}$ variable of Ref. [8] to both determine the best fit parameters and to test the goodness-of-fit.

I analyze two limiting cases of 2.45 MeV neutron emission — no shielding and heavy shielding[11]. In both cases, the detector is placed 30 cm from the flask containing the cavitation fluid, as described in the Letter and supplement. Both radioisotope[9, 10] simulations are performed without shielding. The fit results are summarized in Table I.

TABLE I: Results of fit to simulation.

	$\chi^2_{\lambda,p}$/d.o.f.	p-value	z-value
2.45 MeV	701/473	3.9×10^{-11}	6.5
2.45 MeV w/ shield	664/473	1.4×10^{-8}	5.5
^{252}Cf	454/473	0.72	-0.59
^{239}PuBe	644/473	2.5×10^{-7}	5.0

I rule out the possibility of cavitation 'on' runs being longer than cavitation 'off' runs by comparing the shapes of the spectra in Fig. 9b of the supplement. 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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[1] R. P. Taleyarkhan, C. D. West, R. T. Lahey, Jr., R. I. Nigmatulin, R. C. Block, and Y. Xu, Phys. Rev. Lett. **96**, 034301 (2006).
[2] EPAPS Document No. E-PRLTAO-96-019605.
[3] S. Agostinelli *et al.*, Nucl. Instr. and Meth. A **506**, 250 (2003).
[4] G. Dietze and H. Klein, Nucl. Instr. and Meth. **193**, 549 (1982).
[5] J. B. Birks, *The theory and practice of scintillation counting* (Pergamon Press, Oxford, 1964).
[6] V. V. Verbinski *et al.*, Nucl. Instr. and Meth. **65**, 8 (1968).
[7] B. Naranjo, J. K. Gimzewski, and S. Putterman, Nature **434**, 1115 (2005).
[8] S. Baker and R. D. Cousins, Nucl. Instr. and Meth. **221**, 437 (1984).
[9] A. Lajtai *et al.*, Nucl. Instr. and Meth. A **293**, 555 (1990).
[10] M. E. Anderson and R. A. Neff, Nucl. Instr. and Meth. **99**, 231 (1972).
[11] The flask is inside a paraffin box enclosed on five sides with 10 cm thick walls. The sixth side is open to allow the detector a clear view of the flask.