Comment on: "The interaction of neutrons with $^7$Be at BBN temperatures: Lack of Standard Nuclear Solution to the Primordial $^7$Li Problem by M. Gai et al.

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Abstract

The Authors of this Comment were integral part of the design and execution of the experiments reported by M. Gai et al. in the Conference Proceedings entitled "The interaction of neutrons with $^7$Be at BBN temperatures: Lack of Standard Nuclear Solution to the Primordial $^7$Li Problem. They reject the interpretation of the experiments presented by M. Gai et al. and disavow the extraction of any physical quantity from its results owing to inadequate calibration of tracks formed in CR-39 detectors and to uncontrolled background.
The article by M. Gai et al. [1] is the publication of a preprint posted earlier [2]. It has now been published with an author list representing only a minority of the actual collaboration with no new experimental data or further improvement in data evaluation or method development. This article, which we show below is void of valid physical content, was followed by another publication by E. E. Kading et al. [3] equally inappropriate that we quote below and have also addressed separately. All Authors of this Comment are collaborators or PI (MP) of the reported experiment, holding the original logbooks and disavow the conclusions of [1].

A long list of shortcomings of the experiment and its interpretation by M. Gai et al. was addressed in [4]. We address here first an assignment reported in [1] for the important cross section of the $^7\text{Be}(n,\alpha)$ reaction that we consider unfounded and misleading to the nuclear physics and nuclear astrophysics community. The reported assignment is based on a selective presentation of calibration data for $\alpha$-particles and on their misleading interpretation. The alleged data result from irradiated CR-39 detectors that were subsequently scanned and interpreted in various ways. Figure 1 shows some of the curves used for calibration at different times. Based on their internal inconsistency and contradictory trends, the data are incompatible with the extraction of a quantitative cross section value. Following up the comments in [4], we focus here on the analysis of excess pits analyzed in a CR39 track detector in the radii region of interest (RRI) between 0.8 $\mu$m and 1.4 $\mu$m claimed by M. Gai et al. to be assigned to protons created in the $^7\text{Be}(n,p)$ reaction (Fig. 3 in [1]). We show in Figure 2 the calibration curve reported in a previous publication of the Authors [5]. The curve is a steeply sloping curve making the Authors’ definition of the proton signal, indicated by two red lines, purely arbitrary. It is revealing that in their later publication [3] the Authors of [1] justify this illegitimate RRI assignment for protons by showing (Fig. 3 (bottom) in [3]) an artificial peak created by an arbitrary cut-off at radii smaller than 0.8 $\mu$m.

A detector efficiency for protons of 8.7% is deduced, quoted as 8.7±3% in [1] and as 8.7±1.3% in [3], based on the same experimental data set. In fact, neither of the two quoted uncertainties (34% and 15% relative uncertainty) is realistic because of the large systematic uncertainty, as explained below.

E. E. Kading et al. [3] report an uncertainty of 0.2 $\mu$m for the pit radii determination caused by temperature variations during the etching procedure. Figure 2 clearly shows that
taking this uncertainty into account, the number of pits within the RRI changes dramatically by shifting the RRI on the steep calibration curve by the radius uncertainty. The resulting spread of the detector efficiency varies from 2.2% (RRI 0.6-1.2 \( \mu \text{m} \)) to 22.6% (RRI 1.0-1.6 \( \mu \text{m} \)), when using the data from Figure 2. Consequently, the cross section deduced from the described experiment is uncertain within one order of magnitude or more. It must be added

![CR Calibration Graph](image)

**FIG. 1.** Three different sets of results for the calibration of CR39 track detectors with \( \alpha \)-particles using the same etching conditions (reproduced from [4]): (top) E.E. Kading et al. at CHANDA workshop in November 2015 [5]; (middle) E.E. Kading et al. at NIC in June 2016 [6]; (bottom) M. Gai at NPA8 in June 2017 [7].
FIG. 2. Calibration of solid state CR39 track detectors with 1.4 MeV protons, irradiated at the Weizmann Institute in 2016. Analysis of the solid state CR39 track detector plate used in [1], presented in a poster by E.E. Kading et al. at NIC2016 [5]. The RRI used for the cross section determination in [1] was indicated as two red vertical lines.

that on a methodological point of view, the use of a detection system where small variations induce an order of magnitude change or more in the measured quantity as illustrated in Figure 2, disqualifies the method for a quantitative measurement.

We further examine Fig. 2 in [1] (reproduced here as Figure 3), where the RRI of 0.8-1.4 µm exhibits excess pits of several thousands (marked in dotted-magenta). These excess pits stem from a run with a $^9$Be target, purported to serve as background in these experiments, making one wonder if and what background was used in the extraction of the number of proton pits.

Summary

1. Neither the excess pits observed by M. Gai et al. [1, 2] nor the data analysis are adequate to reflect any connection to nuclear cross sections.

2. Claims and conclusions of M. Gai et al. regarding resulting MACS cross section values must be disregarded.
FIG. 3. Modified Fig. 2 from [1], showing the measured pit radii spectrum from the irradiation of a $^7$Be and a $^9$Be target with neutrons at SARAF. For details, see the figure caption in [1]. Excess pits in RRI 0.8-1.4 $\mu$m, produced from the irradiation of the $^9$Be-target (the background) are marked in dotted magenta.

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