

March 8, 2023

Dear Editor,

I'd like to thank you for your comments and conditioned acceptance of this paper for publication in Universe.

Here are the details in response to your concrete comments:

Comment #1: it is stated clearly that most of the considerations are based on yet unpublished papers of the author, so the review mainly represents an expression of the point of view of the author;

Response to Comment #1:

The basic formation of the new mirror oscillation model discussed in this paper was published in Phys. Lett. B (Ref. [50]). And two followup papers have also been published in Phys. Rev. D (Ref. [53]) and Int. J. Mod. Phys. D (Ref. [60]). However, as reviewer #3 and the editor noted, many other newer updates in this research direction have not been published, and only the author and a small number of experts in the community have recognized the significance of research in this direction. Therefore, we added the following paragraph at the beginning of Sect. III.B on page 18, right before we introduce the mirror oscillation model, for clarity,

“To be clear, theoretical aspects and considerations for new physics discussed throughout this review are based mostly on two published papers [50,53] and two unpublished ones [21,58]. Many new updates (except for Ref. [60]) on the mirror matter theory mentioned in the previous subsection have not been published yet. Therefore, the author takes sole responsibility for the views expressed here.”

Comment #2: the criticisms of the referees are explicitly included even when not in agreement with the point of view of the author.

Response to Comment #2:

Most of the concerns from the reviewers have already been addressed. In particular, all six points from reviewer #2 have been responded to the reviewer's satisfaction. Reviewer #3's comments are addressed in the response above as requested by the editor.

Reviewer #1 seems to have no objection to most of the factual parts of my response. What reviewer #1 disagrees lie on two definitions. One is about “storage time” and “storage lifetime” that the reviewer considers the same. But this is a misuse to say the least. In the literature, as we point out in the previous response letters to the editor and the reviewer, “storage time” has been widely used as the duration time during which UCNs are stored in a trap before counted, which obviously has nothing to do with the lifetime. It is probably fine if the reviewer only uses it in a colloquial way. But we clearly can not make such a misleading identification in the formal paper. This issue seems to be very minor, as no change is needed, although the reviewer felt offended and did some self-explanation.

But the second misidentification is very serious. In this case, reviewer #1 identifies measured

“neutron lifetime” as “neutron beta decay lifetime”. Such an identification basically excludes any discussion of new physics. Indeed, if there is no new physics, any measured “neutron lifetime” should be the same as the “neutron beta decay lifetime”. But this paper is not the only one or for the only model of new physics. There are many tens of published papers about possible new physics related to neutron lifetime. What’s more, several different models of new physics have been proposed and published, and some of them have also been discussed briefly in this paper. In addition, “Neutron lifetime anomaly” has been a very well recognized puzzle in the field, and therefore possible new physics to be revealed from such an anomaly justifies the separation between measured “neutron lifetime” and “neutron beta decay lifetime”.

Instead, in this paper, we made clear distinction between different concepts of measured “neutron lifetime”, “neutron beta decay lifetime”, and “storage lifetime”, e.g., as shown in Table 1 on page 5.

To quote reviewer #1, “... It is also very misleading to imply that the result in Craig Huffer’s PhD thesis was meant as a measurement of the beta decay lifetime ...”, this is where the main criticism from reviewer #1 really lies, but it is actually incorrect as we never claimed that it is a measurement of the beta decay lifetime. The implication is from the reviewer’s misidentification of measured “neutron lifetime” = “neutron beta decay lifetime”.

The measured “neutron lifetime”, by common practices of science, means a measured, finally reported value after taking into all corrections, at least to the best knowledge of the authors. If it is different from known physics (in this case, beta decay lifetime), then people need to re-check their systematics or consider new physics. But one can not just simply blame incorrect systematics and do not allow consideration of any possibility of new physics, in particular, when several different measurements present the similar anomalous behavior.

In the current case, similar anomalous values were observed in all small magnetic trap measurements [20,34,36,37], as discussed in the paper. But reviewer #1 invented a new category of “corrected storage lifetime” used only for Huffer’s measurement (i.e., the NIST Ioffe-type magnetic trap experiment [20]) as the reviewer does not believe in any possibility of new physics and this measurement showed the most convincing evidence of new physics, even after I explained my extensive discussions with the original collaboration group. As I explained in my previous response letters and in this paper (Sect. III.C on page 21), the group even carried out a detailed simulation study using the new model, which amazingly agrees with the model prediction of new physics. Even though I have the writeup of their simulation results, it is probably not appropriate for me to share their unpublished document with you. If you insist, you can contact Kevin Coakley at NIST (kevin.coakley@nist.gov) or let me know so that I can ask him for permission to share it with you.

As I understand, Universe also publishes all relevant review comments and responses after a paper is accepted for publication. I wholeheartedly support such practices and hereby give them my permission to publish all my responses to both reviewers and editors along with the paper if accepted. I truly believe that unbiased readers can make their own judgments based on the full information of the paper and review discussions. This will, undoubtedly, meet the editor’s

requirements, particularly the inclusion of all the criticisms of the reviewers.

Sincerely,

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