# Responses to Referee

immediate

March 16, 2021

**Manuscript Title :** QMetrology from QCosmology: Study with Entangled Two Qubit Open Quantum System in De Sitter Space
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Dear Editor,

We thank the referees for their reports and insightful comments on our work. Based on the comments, we have modified the paper as needed, corrected all the errors that they mentioned and provided clarifications where required. We request reconsidering this paper for publication in SciPost. Below are our responses to the referee's comments :

**Response to Anonymous Report 2**

1. **Referee's Comment :**
   Why is the studied object important? As I also mentioned in the last round of review, dS space does not bring anything noteworthy and therefore the authors must underscore why should we care about this particular problem: does it bring new understanding of quantum metrology (like breaking the no-go theorem of quantum metrology with dephasing, see [1] below), or this particular space is commonly encountered?

   **Authors' Response :**
   We thank the referee for bringing up this question. We would like to say that the studied object potrays the simplest example of an entangled system. In ref. [], the authors showed how the RCPI (resonant Casimir Polder Interaction) between the two entangled qubits can be used to detect spacetime curvature. The Casimir Polder interaction, which arises from the vacuum fluctuations of quantum fields depends on the spacetime curvature. The role of De-Sitter space can be realised from the fact that even though it enjoys the same degree of symmetry as that of Minkowski space, its curvature significantly modifies the RCPI between the entangled qubits. Hence one can extract information about gravity from Casimir physics. The model that we have considered in this paper is a well known one and many authors have studied it in different contexts. Our objective was to use the technique of fisher information

to estimate the most significant parameters of the model. The determination of the explicit role of De-Sitter space in the context of quantum metrology, like the breaking of no-go theorem etc. was not the objective of this paper and hence has not been addressed. It is definitely an interesting problem to address and we are extremely grateful to the referee for pointing this out.

2. **Referee's Comment :**
   For such a simplified system, the author should discuss about what is the best way to fully use the Fisher information in order to estimate the phase. For large scale system this remains an open question, but for 2-qubit system this should be derived and included in the text.

   **Authors' Response :**
   Indeed there exists many literature where people have used fisher information in order to estimate the phase of their system. However, in this paper we have not thought in that direction and focussed on estimating the most significant parameters which are crucial not only theoretically but experimentally. We mainly concentrated on estimating parameters like time scale, interacting strength and euclidean distance which helped us to reach at many interesting concluding remarks, e.g like revival of out-of equilibrium features at late time scales and. We thank the referee for pointing this out towards which we will try to work in future projects.

3. **Referee's Comment :**
   Also, as pointed out by other referees, I recommend the authors to clearly distinguish introduction and review with the original works derived in this paper. Current form of this manuscript is still ambiguous to me.

   **Authors' Response :**
   We thank the referee for suggesting this. We have modifed the draft accordingly. We have clearly mentioned in the modified draft the sections which are just a review needed to familiarise our readers with the model and essential concepts. We have included the technical details about the considered model in a separate appendix in our modifed draft.

We believe that our comments in this report along with the modified version of our manuscript have addressed all the concerns raised by the referees. We, therefore, request the Editor to reconsider our paper for publication in SciPost.