Referee #1 comments: The Afshar experiment, a variation of the double-slit experiment in quantum mechanics, was devised and conducted by Shahriar Afshar in 2004. Afshar asserted that the experiment provides information about the path a photon takes through the apparatus while simultaneously allowing for the observation of interference between the paths. He claimed that this finding contradicts the complementarity principle of quantum mechanics. In response, several experiments have critiqued Afshar's work, including one by Unruh. Unruh, like Kastner, set up a configuration he believes is both equivalent and simpler. His approach magnifies the effect, making it easier to identify flaws in the logic. This article presents a detailed overview of Afshar's original experiment, along with Unruh's experiment and a modified version (Pessoa Junior's), to examine the issues raised by Afshar concerning a potential violation of the complementarity principle.

The authors have digitally simulated interferometric variants of Afshar's experiment using IBM's quantum computers. They have explored the analogous experiments conducted by Unruh and Pessoa Júnior, delving into discussions regarding the apparent violation of Bohr's complementarity principle in the context of the entire experimental setup. Additionally, they have analyzed these experiments within the framework of an updated quantum complementarity principle, which applies to specific quantum state preparations while remaining consistent with the foundational principles of quantum mechanics.

1. I believe that much of the calculations, except for minor errors (e.g. A1 to A5) and analysis is fine.

2. However, I think using a digital simulator on an IBM machine may be a little heavy handed. The analysis could proceed with simple optical experiments on an optical bench, although it may somehow lose some oomphs and also some of the experiments may have already been demonstrated.

3. So, aside from the usual arguments from the proponents and critiques of the original exeriment, what really is new aside from a somewhat trivial application of a quantum simulator. Overall, I think the paper is more suitable for a pedagogical journal. I do not recomment it for SciPost.

Our response to Referee #1: We appreciate the Referee's willingness to review our manuscript. But we respectfully disagree with Referee #1 overall evaluation for the following reasons. We have organized the Referee's remarks into the three outlined items for clarity.

Regarding item 1: We respectfully ask the referee to specify the specific errors found in Eqs. A1 to A5. Despite conducting a comprehensive review ourselves, we were unable to detect any mistakes in these equations.

Regarding item 2: Although we make it clear in the manuscript that the use of the formalism of Mohan *et al.* is essential only for Pessoa Júnior's setup, it is important to point out that not even Unruh's experiment has been carried out using optical devices to date, at least to our knowledge. The reason behind this is precisely the experimental difficulty in an optical bench of even running the usual Mach-Zehnder interferometer (MZI), which are preferably performed in analog versions such as the Sagnac interferometer. Although the modified version of the Unruh experiment is feasible using optical instruments, such

as the experiment performed in Ref. [1], Pessoa Júnior's experiment is much more challenging, and, as far as we know, there are no experiments that resemble this setup. It is also worth mentioning that digital simulations can be extended to even more complicated experimental setups, with a larger quantity of optical devices and higher occupation numbers, whose implementations (Ref. [2]) are difficult and relatively novel in the field.

Regarding item 3: Our article is completely built around three points: (*i*) extending and employing the framework established by Mohan *et al.* to (*ii*) conduct a thorough examination of two comparable versions of Afshar's experiment: a modified version of Unruh's experiment and Pessoa Júnior's experiment, and (*iii*) examining these experiments with regard to the newly proposed quantum complementarity principle. All of these points are new in the literature. Our research is based on the recent methodologies outlined by Mohan *et al.*. So, we are confident that our work has the relevance and novelty needed for justify its publication in SciPost.

References

[1] J. Li *et al*., Superposition-state generation of nonorthogonal wavelike and particlelike states without ancillary qubits, Phys. Rev. A **108**, 2, doi: 10.1103/PhysRevA.108.022221.

[2] M. Quensen *et al*., Hong-Ou-Mandel interference of more than 10 indistinguishable atoms, https://doi.org/10.48550/arXiv.2504.02691.