ČVUT
ČESKÉ VYSOKÉ UČENÍ TECHNICKÉ V PRAZE

# REVIEWER´S ASSESSMENT OF FINAL WORK

## I. IDENTIFICATION DATA

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|---|---|
| **Title:** | **Non-Gaussian Boson Sampling** |
| **Author´s name:** | **Meet Rajkumar Panchal** |
| **Type of assignment:** | Master Thesis |
| **Faculty:** | Faculty of Nuclear Sciences and Physical Engineering (FNSPE) |
| **Department:** | Department of Physics (DP) |
| **Reviewer:** | Michael Stefszky |
| **Reviewer´s affiliation:** | Paderborn University |

## II. ASSESSMENT OF CRITERIA

**Work assignment** — **demanding**

*Assess how demanding the work topic is.*

Gaussian boson sampling is a topic that requires expertise in a number of different fields such as set theory, quantum optics and complexity theory in order to reach a full understanding. In my opinion the presented thesis shows a good understanding of these core concepts.

**Fulfilling the assignment** — **fulfilled**

*Consider whether the work submitted meets the assignment. If necessary, give your comments on items of the assignment not fully answered, or judge whether the scope of the assignment has been broadened. If student failed to fully treat the assignment, try to assess the importance, impact and/or the reasons for the failings.*

The presented Master thesis shows a good understanding of the core concepts and introduces new work in the form of investigating bunching with non-Gaussian input sttes.

**Chosen approach to solution** — **appropriate**

*Assess whether student applied a correct approach or method of solution.*

The task has been approached from multiple angles. The bunching has been investigated using the correlation value and the ratio of interest for Fourier interferometers and randomly selected unitaries.

**Professional standard** — **excellent**

*Assess the professional standard of the work, application of course knowledge, references, and data from practice.*

The thesis is written very well for a Master's level work and clearly shows a good understanding of the core concepts involved. The relevant references seem to have been included and the context of the work is clear.

**Level of formality and of the language used** — **excellent**

*Assess the use of scientific formalism, the typography and language of the work.*

The level of formality and language in the work is very good for a Master level thesis. New concepts are introduced clearly and the flow of the thesis is very easy to follow.

**Choice of references, citation correctness** — **excellent**

*Assess student´s effort in finding and using study sources for completing their work. Give characteristics of the references chosen. Assess whether student made use of all the relevant sources. Verify whether all items used are properly distinguished from the results obtained by student and their deliberations, whether there are no violations of citation ethics, and whether the bibliography presented is complete and complies with the citation usage and standards.*

The work provides a good overview of the historical context of the work with relevant citations. Furthermore, as the work progresses to the current state of the art, the most important citations have again been included. The work of the student has been put into context in regards to previous work and a clear distinction has been made between what has been previously presented and what are the new contributions to the field. In my opinion the citations are complete and comply with the usual standards.

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**Further comments and assessment**

*Give your opinion on the quality of the main results obtained in the work, e.g. the theoretical results, or the applicability of the engineering or programming solutions obtained, publication outputs, experimental skills, and the like.*

As stated previously, the student clearly has a good grasp of the core concepts. This leads to a very clear introduction and background to the presented work, at a level that I would consider average for a PhD student and advanced for a Master level student.

The new work presented by the student is primarily concerned with investigating the bunching seen in a sampling setup when a particular form of Non-Gaussian input state is utilised, in contrast to the more typically seen squeezed states or single-photon input states. The context of the new results is the only part of the thesis that, in my opinion, is missing some context. For example, bunching is investigated in Fourier matrices of multiple size, but the reason for investigating this class of matrix is not stated and therefore the impact of the results is not fully clear to me. The student finds clustering in both Fourier matrices and some random set of matrices, but does not very clearly discuss the significance of bunching at the output. The student does show that the results align with previous investigations, but does not go deeper into the impact that non-Gaussian states might have, in contrast to previous work.

In summary, the presented work demonstrates a very good understanding of the concepts and the thesis is written very well for a Master level work. The new results presented are well done and scientifically sound but, in my opinion, lack some context.

## III. OVERALL ASSESSMENT, QUESTIONS TO BE ASKED DURING THE WORK DEFENCE, SUGGESTED GRADE

*Summarize those aspects of the work that were significantly influential for your overall assessment. Suggest questions to be answered by student during the defence of the work before the examination board.*

The presented topic requires a very broad expertise for meaningful investigation and the student has shown a level of understanding that is above that expected for a Master level student.

Furthermore, the writing style and clarity of text are excellent.

Although the context of the presented results could use a bit more context, the results are nevertheless well explained and they are compared to previous work.

Question 1: How does the Non-Gaussian state generator scheme from Fig 2.4 allow for producing arbitrary pure single-photon states?

Question 2: Eq. 3.1 shows the form of non-Gaussian state that is investigated in this thesis. What limitations might this particular form introduce?

Question 3: Explain the Hong-Ou-Mandel effect and what effect imperfections will have on the outcome.

Question 4: In your work you have investigated the bunching in sampling outcomes with a non-Gaussian input state, but how does the amount of bunching relate to that seen in, for example, GBS.

Suggested grade: **A - excellent.**

Date: 23/05/2024

Signature: