

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Nikita Stroev

PhD Program: Physics

Title of Thesis: Modelling of exciton-polariton condensates for unconventional computing

Supervisor: Professor Natalia Berloff

Name of the Reviewer:

I confirm the absence of any conflict of interest

(Alternatively, Reviewer can formulate a possible conflict)



Date: 18-11-2021

The purpose of this report is to obtain an independent review from the members of PhD defense Jury before the thesis defense. The members of PhD defense Jury are asked to submit signed copy of the report at least 30 days prior the thesis defense. The Reviewers are asked to bring a copy of the completed report to the thesis defense and to discuss the contents of each report with each other before the thesis defense.

If the reviewers have any queries about the thesis which they wish to raise in advance, please contact the Chair of the Jury.

Reviewer's Report

Reviewers report should contain the following items:

- Brief evaluation of the thesis quality and overall structure of the dissertation.
- The relevance of the topic of dissertation work to its actual content
- The relevance of the methods used in the dissertation
- The scientific significance of the results obtained and their compliance with the international level and current state of the art
- The relevance of the obtained results to applications (if applicable)
- The quality of publications

The summary of issues to be addressed before/during the thesis defense

This thesis is devoted to various aspects of complicated systems modeling. A new way to adjust and hence to complicate the system of exciton-polariton condensates was shown, which is based on the multiple condensates interference and results in the increasing complexity of the computational task. The connection between the physical parameters and the complexity of the assignment was demonstrated. An algorithmic heuristic which is referred to as Complex-Coupling switching was obtained. The initial idea of the procedure is to be applied to the experimental setup to enhance its performance. The heuristic itself was shown to outperform (in theory) the conventional Hopfiled neural networks on instances of the random tensor sum minimization and is of particular interest for the algorithmic purpose. The analytical description of periodic structures in the exciton-polariton settings was obtained. A new phase diagram for the condensate behavior was built and the range of possible parameters, including the velocity profile, was derived. The last two chapters deal with rather abstract models I am not an expert in.

The topic of the dissertation is relevant to its actual content and the methods used are appropriate for the considered tasks. The results are published in the leading international journals that shows their scientific significance.

The summary of issues to be addressed before/during the thesis defense:

The estimation of the validity of the used equations should be addressed and discussed in the text of the thesis.

The proposed heuristic itself was shown to outperform (in theory) the conventional Hopfiled neural networks. However it is not at all clear how these theoretical proposals can be implemented experimentally as the measurement of the key variables of the model is a rather hard task, not to say about their control.

The thesis is overloaded with formal terms and mathematical discussions. On the contrary the physical mechanisms and the related limitations are less presented.

Minor typos:

P.16 "Hopfiled NNS". (In the rest of the text NNs) -> Hopfiled neural networks (NNs)

Use of EP for exciton-polariton is a bit misleading, is it different from common LP (lower polariton) branch? Seems the LP case is considered in the thesis. What is the reason for new notation?

Provisional Recommendation

I recommend that the candidate should defend the thesis by means of a formal thesis defense

I recommend that the candidate should defend the thesis by means of a formal thesis defense only after appropriate changes would be introduced in candidate's thesis according to the recommendations of the present report

The thesis is not acceptable and I recommend that the candidate be exempt from the formal thesis defense