Skoltech
Skolkovo Institute of Science and Technology

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Stepan Baryshev

PhD Program: Physics

Title of Thesis: Photon correlations of optically trapped polariton condensate

Supervisor: Professor Pavlos Lagoudakis
Co-supervisor: Dr. Anton Zasedatelev

Name of the Reviewer: Prof. Dmitry Gorin

I confirm the absence of any conflict of interest	**Date: 27-09-2022**

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

In his PhD thesis, Stepan Baryshev , entitled "PHOTON CORRELATIONS OF OPTICALLY TRAPPED POLARITON CONDENSATE ", describes a low-temperature PL spectra revealed characteristic triplet fine structures, photon correlations in a spinor exciton-polariton condensate, the Hong-Ou-Mandel effect of optically trapped polariton condensate, etc. This thesis is clearly written and well organized. It presents novel scientific results in the areas of polaritonics.

The PhD thesis contains 6 Chapters. The Chapter 1 is an introduction. It describes research gaps, obtained results as well as structure of PhD thesis. Chapter 2 presents results of study of carbon mono-chains lifetime dynamics and presence of fine spectral structure at liquid helium temperature. In Chapter 3, it was discussed the general theory of the polaritons and polariton condensates, as well as present our experimental technique of characterization of polariton condensate. Chapter 4 considered the photon statistics of the polariton condensate and show the non- trivial dynamics of its spinor, as well as the controlling the emitted photon statistics by the variety of ways. Chapter 5 is related to the experimental observations of Hong-Ou-Mandel effect for the trapped polariton condensate and give possible explanations of the observed behaviors. Chapter 6 contains the key obtained results and the express ideas for future improvements. The bibliography list consists of 189 references. The quality of writing and print design is very high. The author uses the LATEX for thesis processing. Obtained results can be interesting for study of system with chaotical behavior.

The main part results of PhD thesis have been already published in the best international journals in the field of this research including Physical Review Letter (IF=9.185, NI journal), Nanoletters (IF=11.38, NI journal), Phys. Rev. B, (4.036) etc.

The text of PhD thesis is solid and is presented in a cohesive way. However, I have few comments to be addressed to the author for improve the quality of this PhD thesis:

1. Page 17, please write nano- and particle as one word – nanoparticles.
2. Page 17, Adding DLS results as well as TEM images of gold nanoparticles could be useful;
3. I did not find any information about substances that have been used for gold nanoparticle surface modification as well as description of gold nanoparticle synthesis. This information should be added to the PhD thesis.
4. Why did author use the gold nanoparticles at two sizes 10 and 100 nm? Please add an explanation of this chose as well as errors for nanoparticle size evaluation;
5. Page 18, Figure 2-2 (b), why do not I see any gold nanoparticles in the HR-TEM images?

I think that results of measurements of the extinction spectra of gold nanoparticle/carbon chains could be useful. You can compare your results with the data have been described in the following references [A.M.Yashchenok et al J. Biophotonics, 2016, 9, 792, A.M.Yashchenok, Small 11.11 (2015): 1320]

After correcting some minor points mentioned above, I recommend that should defend the thesis by means of a formal thesis defense.

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*