

## Jury Member Report – Doctor of Philosophy thesis.

**Name of Candidate:** Anton Putintsev

**PhD Program:** Physics

**Title of Thesis:** Ambient Polaritonics

**Supervisor:** Professor Pavlos Lagoudakis

**Co-supervisor:** Dr. Denis Sannikov

**Name of the Reviewer:** Simone De Liberato

I confirm the absence of any conflict of interest  (Alternatively, Reviewer can formulate a possible conflict)	<b>Date:</b> 31-10-2022
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*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**

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- Brief evaluation of the thesis quality and overall structure of the dissertation.

In this thesis, the Candidate investigates various aspects of the physics of organic polariton condensates:

The first Chapter contains a brief but clear outline of the rationale, of the objectives, and of the structure of the thesis.

The second Chapter provides an introduction to strong coupling, polariton condensation, and organic polaritons. This Chapter is rather short, but overall clear and complete, and it provides the reader with the basic concepts necessary to understand the rest of the thesis.

In the third Chapter the exposition of the original thesis' work begins in earnest, reporting and discussing results demonstrating long-lived single-mode polariton lasing in an organic cavity. The data reported are clear and well explained, and the demonstration of quasi-steady state lasing convincing.

The fourth Chapter investigate the efficiency of hybrid metal-DBR mirrors for organic polariton condensates, extensively characterizing the design and the performances of such devices. The Chapter is interesting and very well developed, providing clear guidance for the engineering and use of the hybrid mirror design.

The fifth Chapter reports the development of a single-shot approach, originally used in atomic condensates, to measure second-order coherence in organic polariton condensates. This approach is then exploited to characterize a polariton condensate varying its size.

The thesis is closed by a Summary and Outlook Chapter which, although as clear and well written as the rest of the thesis, is mainly a Summary as it includes little of the personal Outlook of the Candidate.

The thesis is overall of high quality. It reports interesting and potentially important results. The manuscript is clear and will serve as a useful tool for future generations of researchers.

- The relevance of the topic of dissertation work to its actual content

The thesis is extremely relevant to the topic of the dissertation work, investigating various aspects relevant to room temperature polariton condensates. The manuscript touches topics relevant to device operation (quasi-steady state lasing), to device engineering and optimization (hybrid mirror), to novel approaches to device characterization (single-shot photon statistics).

- The relevance of the methods used in the dissertation

The methods used by the Candidate are extremely relevant for the topic of the dissertation. Both experimental and numerical methods represent or advance the state-of-the-art in the field of polaritonics.

- The scientific significance of the results obtained and their compliance with the international level and current state-of-the-art

The quality of the results reported complies with and advances the state-of-the-art in the field of polaritonics and quantum optics.

- The relevance of the obtained results to applications (if applicable)

The results obtained on both the quasi-steady state polariton lasing and on the hybrid microcavity design represent important contributions toward the use of polariton condensates in practical optoelectronic devices.

- The quality of publications

This thesis work led to 2 research papers, with one more under review. The Candidate is first author of two of them, one published and one under review in top-tier journals. Overall, the quantity and the quality of publications is more than acceptable for a PhD project.

There are only few suggestions the Candidate should consider:

On page 28, “Onc” should be “One”.

In Figure 5-9 there is a “-1” missing in the axis of the bottom-left panel.

The set of equation 5.11-5.13 could be explained in greater details.

The last Chapter could stress a bit more the personal outlook of the Candidate.

#### **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*