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Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Igor Ermakov

PhD Program: Physics

Title of Thesis: Dynamics of exceptional states in many-body systems

Supervisor: Professor Boris Fine
Co-supervisor: Dr. Oleg Lychkovskiy

Name of the Reviewer: Vladimir Gritsev

I confirm the absence of any conflict of interest (Alternatively, Reviewer can formulate a possible conflict)	**Date: 13-09-2022**

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

The thesis by Igor Ermakov is devoted to analysis of cases where quantum and classical systems could avoid thermalising behaviour or greatly suppress it. I think it is high-profile work, coherently written and dealing with hot topics of contemporary research interests. In the Second Chapter Igor is analysing possible relationship between classical periodic trajectories and quantum many-body scars. Several regimes of classical dynamics are found and the concepts of finite size quantum scars and quantum separatrix are introduced. Third Chapter suggests an interesting procedure for robust designing of quantum states which almost revive at definite instances of time. Several interesting applications of this procedure are suggested. In Chapter 4 Igor discussed non-classical states in the model of collisional decoherence.

I have some comments and questions which should be addressed before the defence:

- On p.21 there is unfinished sentence just in the end of a section. I am curious what the author wanted to say there…
- On p.26 two paragraphs literally repeat what was already said on p.19. I recommend some rephrasing here.
- It would be nice to explain why in the model of Chapter 2 the very special point in the parameter space is chosen (J_y=2J_x).
- Very mysterious periodicity of period 6 in the system size needs further thought. Perhaps by enlarging the space of parameters (see above) one could find some hints for explaining this phenomenon.
- I feel that the procedure of finding L-dependence of the Liapunov exponent would need more explanations at the bottom of p.34. The author refers to a one-spin Hamiltonian at this point which obviously has no L-dependence. This is confusing…
- On plot 2.4 \alpha is not defined (I also did not find it in the text, but possibly overlooked it).
- I would recommend to put more thoughts on the nature of breakdown of translational invariance.
- What are boundary conditions in Section 2.5.
- It would be nice to see a clear definition of \bar{E}(|E_n >) in 2.5.2.
- General remark: please proofread the text. Repetitions like “between clearly between” or things like “Lyapunovexponent” pop up from time to time.

Provisional Recommendation

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