Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Kirill Pavlenko

PhD Program: Mathematics and Mechanics

Title of Thesis: Quantum KdV charges, 2d conformal theories and eigenstate thermalization hypothesis

Supervisor: Associate Professor Anatoly Dymarsky

Name of the Reviewer: Julian Sonner

I confirm the absence of any conflict of interest (Alternatively, Reviewer can formulate a possible conflict)	**Date: 21-08-2022**

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 "Quantum KdV charges, 2D conformal field theories and eigenstate thermalization hypothesis" presents a significant amount of interesting and mathematically non-trivial results concerning the over-arching theme of quantum thermalization in two-dimensional conformal field theories, with a particular emphasis put on such theories which exhibit a large central-charge limit. To state this at the outset: this is a high-quality piece of research, and while technical in nature, the thesis is a pleasure to read and as easy to follow as could be hoped given the complicated nature of some of the material.

The highlight of the work is a detailed comparison of the behavior of operator expectation values in highly excited pure states and the generalized Gibbs ensemble (GGE) of KdV charges, which is carefully introduced and defined both at the classical and quantum level. The thesis uses the wide toolkit of 2D CFTs to find a number of expansions of the associated KdV charges, their spectrum and their relevance to the GGE. The scenario developed in this thesis, and the papers it summarizes is dubbed 'Generalized ETH' and the study is not only intrinsically of great interest, but also highly relevant in the context of the holographic study of three-dimensional black holes in asymptotically anti-de-Sitter space. The results are very timely, and it may reasonably be expected that they will inform ongoing and future work in this exciting and active field.

The thesis is well written, although rather brief, focusing almost exclusively on the novel results obtained, without giving too much background material and wider discussion (this may be the expected format). I nevertheless find that the author has successfully included a number of pedagogical explanations that are valuable to the readership.

The overall topic arises from a clear and simple-to-state question "Do 2D CFTs thermalize, and if so, how?" and manages to establish a number of useful and relevant results. In fact, these results are of high-enough standard to be appreciated by the wider (international) theory community. They should be of interest both to statistical physicists as well as high-energy theorists working in the field of holographic duality.

The quality of the associated publications is throughout high and of internationally visible standard. In fact, they were familiar to me, independently of reading the present thesis, as a further illustration of their standing and visibility in the international research community.

Some minor issues relating to the English language are visible throughout the thesis, but none that would impede understanding of the material presented in any way. In conclusion, and as indicated below, I recommend that the candidate should defend the thesis by means of a formal thesis defense.

Provisional Recommendation

x *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*