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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: Alexander Gorsky

I confirm the absence of any conflict of interest	**10-08-2022**

Reviewer's Report
The PhD dissertation of Kirill Pavlenko is devoted to the important issues concerning the 2d conformal field theories their deformation to the KdV integrable model and the relation of the findings to the eigenvalue thermalization hypothesis. It is original study performed at a high level. The topic of the dissertation fits with its actual content perfectly. The methods developed in the 2d conformal field theory, theory of integrable systems and geometrical quantization of the coadjoint orbits used in the dissertation certainly are relevant for the study.   The dissertation consists from eight Sections. In Section 2 the general aspects of the finite-gap integration approach in the theory of integrable systems have been reviewed. In Section 3 the method of coadjoint orbit quantization has been applied to derive the quantum higher KdV charges. In Section 4 the Generslized Gibbs Ensemble with involves the higher KdV charges is introduced and investigated. The results of the previous Sections have been applied to the problem of derivation of zero modes of local operators in 2d CFT. In Sections 6-7 the interplay between the ETH and CFT is elaborated and the new generalized eigenvalue thermalization hypothesis is formulated and checked in some examples.

The results obtained in the dissertation are at the highest international level and are accepted by scientific community. They have been published in the leading international journals in mathematical physics. Without any doubts they are of great importance for the further study in the conformal field theories and their applications to a very wide class of the critical phenomena.

There are a few points to be mentioned. Fisrt,to my mind the dissertation is overloaded with the technical details which makes the reading a bit difficult. As for the questions concerning scientific issues I would like to mention a few which deserve a more detailed study in the future

1. The selected quantization scheme provides the reasonable answers but certainly deserves for further justification at the theoretical level. This subtle point is mentioned in the dissertation.

2. The KdV hierarchy allows two different Hamiltonian representations with Virasoro and Kac-Moody Poisson brackets. The author investigated the quantization of the higher charges from the Virasoro viewpoint but it would be important to make the comparison with the second Hamiltonian picture.

3. The auther considered the quantization of the coadjoint Virasoro orbirs of the general type. It would be important to perform the similar analysis for the special Virasoro orbit and discuss the impact of the topological windings.

4. The attempt to develop the holographic interpretation for the findinds in the dissertation seems to be very preliminary and not elaborated in details.

Provisional Recommendation

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

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