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Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Aleksey Lunkin

PhD Program: Physics

Title of Thesis: Sachdev-Ye-Kitaev model in the presence of the quadratic perturbation

Supervisor: Assistant Professor Konstantin Tikhonov

Name of the Reviewer: Prof. Nikolay A. Gippius

I confirm the absence of any conflict of interest	**Date: 20-06-2022**

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

The topic of the thesis is related to the study of the non-fermi-liquid properties. Particularly, thesis is devoted to the study of the stability of properties of the Sachdev-Ye-Kitaev (SYK) model with respect to the quadratic in fermions perturbation.

The original SYK model demonstrates non-fermi-liquid properties due to the absence of the fermi surface. As a result, the interaction plays the crucial role. The SYK model is analytically solvable and demonstrates two regimes. Firstly, saddle-point solution describes behavior of the system for short times. Secondly, there are strong fluctuation which should be taken into account to describe system for long times. The considered perturbation should restore the fermi-liquid behavior. Author shows that there is a region of stability of the SYK model in the parametric space i.e. sufficiently small perturbation does not change properties of the model.

The thesis structure is the following. The first chapter describes the history of the fermi-liquid theory and the SYK model. The main properties and approaches of the SYK model are written in the second chapter of the thesis. Both these chapters could be considered as an introduction to the problem. The third chapter consider the problem of the stability in the zero temperature case using perturbation theory. It was shown that the correction to the Green's function does not change the asymptotic behavior. The case of the non-zero temperature was considered in the fourth chapter. The self-consistent approach was suggested to consider this problem. Author shown that sufficiently strong perturbations leads to the suppression of the fluctuation. As a result the saddle-point approach is applicable also for long times. The last chapter of the thesis is a conclusion. Thesis also contains two appendices with technical details.

The theoretical work in the thesis is of high quality. The result of the work very published in the "Physical review letters" which is a highly-citated journal.

The thesis is well organized but the language is quite poor.

Authors study the behavior of the system using imaginary times. So the question about the behavior of the Green function on long real times is still open. It could be taken into account in the further research.

As a result, I recommend this thesis to the 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*