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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. Dr. Igor Burmistrov

I confirm the absence of any conflict of interest	**Date: 03-06-2022**

Reviewer's Report

The dissertation by Alexey Lunkin is devoted to the study of Sachdev-Ye-Kitaev (SYK) model. This model combines (strong) interaction of fermionic degrees of freedom and randomness. Formulation of the model as zero-dimensional one allows to develop not only the saddle-point-type solution but also to go beyond the mean field approximation. Recently, there is an increased interest to this model as a solvable example of strongly interacting disordered fermionic system demonstrating non-Fermi liquid behaviour. The thesis is aimed to the extension of the SYK model with respect to inclusion a (quadratic) term responsible for the Fermi-liquid type behaviour. The main question addressed here is how the crossover from non-Fermi liquid to Fermi liquid behaviour occurs.

The dissertation by Alexey Lunkin is based on two papers published in Physical Review Letters - one of the top professional physical journals. Since the style of the papers is of a Letter type the thesis is written in an extremely concise form. The thesis contains introductory part into the subject of the research - a realm of SYK model (Chapter I) and technical formulation of SYK model in Chapter II. Chapter III contains results on SYK model with quadratic perturbation. There are reported results on treatment of perturbed SYK model based on a geometric interpretation in Chapter IV. The technical details necessary for understanding derivation of results reported in Chapters III and IV are given in two Appendices.

The title of the thesis fits perfectly it's content. The authors used the modern and powerful methods of theoretical physics (effective action, functional integration, perturbation expansions in small parameter). These methods are fully adequate and allow to derive new and interesting results.

The obtained results form an international scientific level in the field of SYK model. They have already acquired scientific significance and well-known for the experts. The two Letters on which the thesis is based are cited more than 20 times. The results were reported at various scientific conferences and seminars.

I have no comments on the thesis except a minor one: a bit less concise form of the presentation of the results including more extended discussion of their physical meaning would be helpful.

Nevertheless, I have no doubt that the thesis "Sachdev-Ye-Kitaev model in the presence of the quadratic perturbation" satisfies all criteria necessary for the Doctor of Philosophy thesis. In my opinion Alexey Lunkin deserves PhD in physics degree.

Provisional Recommendation

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

Prof. Dr. Igor Burmistrov

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