OPINION

on a competition for an academic position

"associate professor" in the field of higher education 4. Natural sciences, mathematics and informatics, professional direction 4.5. Mathematics, scientific specialty "Geometry and Topology" (Tropical geometry) for the needs of IMI-BAS,

announced in SG no. 106/17.12.2024 and on the website of IMI-BAS

The opinion was prepared by: Academician Stefan Petrov Ivanov - FMI at SU and IMI-BAN, professional direction 4.5 Mathematics, scientific specialty "Geometry and Topology" (Differential Geometry), in his capacity as a member of the scientific jury for the competition according to Order No. 347/1.10.2024 of the Director of IMI-BAS.

Only one candidate submitted documents for participation in the announced competition: Dr. Mikhail Stanislavovic Shkolnikov, researcher at the International Center for Mathematical Sciences, IMI-BAS.

1. General description of the presented materials

The documents submitted by the candidate in the competition correspond to and even exceed the requirements of the Law on the Acquisition of Scientific Degrees and Academic Positions and the Regulations for the terms and conditions for acquiring scientific degrees and occupying academic positions at the IMI-BAS.

To participate in the competition, the candidate Dr. Mikhail Shkolnikov submitted a list of 13 titles in total, 10 publications are in journals with impact factor as follows Q1-5, Q2-1, Q3-2, Q4-2, 2 with SJR, Q2-1,Q3-1 and 1 in a refereed journal with a total impact factor of 34.553. A list of 20 citations of the competition papers has been provided, with a total of 42 citations.

He had 3 research projects of the Swiss Research Fund.

2. Brief professional and biographical details of the applicant

The candidate Mikhail Shkolnikov was born on 04.10.1991 in Russia. He was a student of Mathematics at St. Petersburg State University, where he graduated in 2012. In 2013 he received a Master's degree in Mathematics from the University of Geneva, Geneva, Switzerland.

In the period 2013-2017 he was a PhD student in Mathematics at the University of Geneva, where he defended his PhD thesis in 2017 and received a PhD in Mathematics from the University of Geneva, Geneva, Switzerland. During the period 2017-2019 he was a postdoctoral fellow in mathematics at the Institute of Science and Technology of Austria, and in 2019-2020 he was a postdoctoral fellow in mathematics at the University of Geneva, Geneva, Switzerland. From 2023

he became a researcher at the International Center for Mathematical Sciences, IMI-BAS, where he has been working ever since.

3. General description of the candidate's scientific works and achievements

Dr. Mikhail Shkolnikov's research interests are mainly in the field of tropical geometry, which is an intersection of string theory, mirror symmetry, computational algebra, and other interacting fields. The methods of tropical geometry are a combination of algebraic geometry, mathematical physics, and computer science.

These are difficult and relevant areas of modern mathematics and mathematical physics worldwide, where mathematicians such as J. Eliashberg, L. Katsarkov, T. Pantev**,** the Fields laureate M. Kontsevich and others worked.

The candidate has submitted 13 scientific publications, in Q1-5 in Q2-1 in Q3-2 in Q4-1 and I will mention the journals Proceedings of the National Academy of Sciences of the United States of America, - 2, Phys. Rev. Lett. -1, Comm. Math. Phys-1, Bull. LMS-1, etc.

No plagiarism has been proved in the scientific papers submitted to the competition.

Obviously, the presented scientific works significantly exceed the minimum national requirements (according to Article 2b, paragraphs 2 and 3 of the Law on Scientific Research) and respectively the additional requirements of IMI-BAS for holding the academic position "Associate Professor" in the scientific field and professional direction of the competition.

4. Analysis of the applicant's scientific and scientific-applied achievements contained in the materials for participation in the competition

In my opinion, the contributions of Dr. Mikhail Shkolnikov to the research of tropical geometry, quantum systems, solitons, integrable systems and algebraic geometry are indisputable.

Suffice it to mention that a new tropical model with self-organized criticality behavior (the so-called SOK-model) is presented. Unlike all known SOK-models, the presented model is continuous and represents a certain scaling limit of the sandpile model, which is the first and archetypal SOK-model. The relation of this model to the formation of proportional growth patterns and phenomena is described and the dichotomy between continuous and discrete models is discussed in a variety of contexts.

The theory of tropical series, originally arising in the study of the growth of pluriharmonic functions, was also developed. Motivated by the waves in sand patterns, dynamics on the set of tropical series is introduced, and it is experimentally established that these dynamics obeys a power law.

It is also worth noting that a new approach to interaction in quantum many-body systems is presented, based on the notion of quantum groups, also known as q-deformed Lie algebras. It is shown that if the symmetry of a free quantum particle corresponds to a Lie group G, in the presence of a many-body system this particle can be described by a deformed group Gq. A key point is that

the single deformation parameter, q, contains all the information about interactions in the system. To illustrate this approach, a quantum rotor interacting with a bath of bosons (Bosonic bath) is considered, and it is shown that the value of the parameter q obtained from analytical solutions in the perturbative regime allows one to predict the behavior of the system for arbitrary values of the interaction strength. The value of the deformation parameter allows to predict at what values of pairing the interactions between the rotor and the bath lead to the formation of a stable quasiparticle. The quantum group approach not only greatly simplifies impurity problems, but also provides valuable insights into the hidden symmetries of interacting many-particle systems.

The quality of his work is evidenced by the corresponding high numerical indicators: Dr. Mikhail Shkolnikov has submitted 13 publications for the competition and in all articles he has documented a significant contribution. I will note the publications in **Proceedings of the National Academy of Sciences of the United States of America**, - 2, **Phys. Rev. Lett.** -1, **Comm. Math. Phys**-1, **Bull. LMS**-1 as the cumulative impact factor of the competition publications is 34.553. There are also 20 citations listed for these papers, bringing the total number of citations for the candidate to 42.

5**. Conclusion about the application**

Having read the materials and scientific works submitted in the competition and based on the analysis of their significance and scientific and applied contributions contained therein, **I confirm** that the scientific achievements meet the requirements of the Law on Research and Development, the Regulations for its application and the relevant Regulations of IMI-BAS for the appointment of Dr. Mikhail Shkolnikov to the academic position of Associate Professor in the professional field and scientific area of the competition. In particular, the candidate satisfies the minimum national requirements and the additional requirements of BAS in the professional field and no plagiarism has been found in the scientific works submitted for the competition.

I give my **positive** assessment of the application.

II. General Conclusion

Based on the above, **I recommend** the scientific jury to propose to the competent authority for the selection of the IMI-BAS to elect Dr. Mikhail Stanislavovic Shkolnikov to occupy the academic position of "Associate professor" in professional direction 4.5. Mathematics (Tropical geometry).

12.03.2025 г. Prepared the opinion: .....

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