OPINION

by assoc. prof. Ivan Minchev,
FMI, SU „St. Kliment Ohridski“

on a competition for the academic position associate professor in the area of higher education 4. Natural sciences, Mathematics and informatics; professional direction 4.5. Mathematics; scientific specialty Geometry and topology (Tropical geometry), published in the Bulgarian state newspaper no. 106/17.12.2024 г.,

This opinion was prepared by assoc. prof. Ivan Minchev from the Department of mathematics and informatics, Sofia University “St. Kliment Ohridski”, as a member of the scientific Jury for the competition in professional direction 4.5. Mathematics, scientific specialty Geometry and topology (Tropical geometry) in accordance with the Order № 15/17.02.2025 of the Director of IMI-BAS.

The only candidate to apply for the position is **Mikhail Shkolnikov, PhD**.

General description of the submitted materials

The documents submitted by the candidate satisfy the requirements imposed by the Bulgarian Law and also the Regiment of the Bulgarian Academy of Sciences concerning the procedures for promotions and assumption of Academic position at the Academy.

The candidate Mikhail Shkolnikov, PhD, submitted for this competition a list of 13 titles, as follows: 10 papers that are published in journals with impact factor, of which five are with quartile Q1, one is with quartile Q2, two are with quartile Q3, and two are with quartile Q4. The remaining 3 papers are published in journals without impact factor, of which two are in a journal with SJR, and one is in an indexed journal. The scientific works presented by the candidate do not repeat those submitted for previous competitions or promotions. There are no indications

for any existence plagiarism in the scientific papers submitted for the competition. All the documents are presented in accordance with the low and show without any doubt that the candidate fulfils all the requirements of the low for acquiring the academic position associate professor.

The submitted documents describe in detail the candidate's research and teaching activities. These documents represent a strong evidence that Mikhail Shkolnikov has developed rich and ample scientific and teaching activities, and has obtained significant mathematical results satisfy the requirements imposed by the Bulgarian Law, and respectively by the additional requirements of the Bulgarian Academy of Sciences, for assumption of the academic position of associate professor.

Candidate's Bio

The candidate, Mikhail Shkolnikov, obtained his Master's degree in Mathematics at the University of Geneva in 2013. Between 2013 and 2017 he was a PhD student at the University of Geneva with advisor Grigory Mikhalkin. He received his PhD in 2017. The title of his dissertation theses is "Tropical Curves, Convex Domains, Sandpiles and Amoebas". Between 2017 and 2019 he is working as a postdoc at the Institute of Science and Technology Austria. Between 2019 and 2020 he is a postdoc the University of Geneva. Since 2023 the candidate is a researcher at the Bulgarian Academy of Sciences – Institute of Mathematics.

Outline of the Candidate's scientific results and achievements

The candidate has conditionally grouped the scientific publications presented in the competition into several thematic areas, as follows:

1. Non-abelian tropicalization;
2. Tropical sandpile;
3. Tropical optics;
4. Extended sandpile.
5. Quantum topology.

Publications [11] and [13] are devoted on the first thematic area; [3], [4], [5], [9], and [12]– on the second. The third thematic area is considered in [7] and in one other paper “Wave fronts and caustics in the tropical plane” of the candidate that has not been enlisted for the competition. Publications [8] and [10] are included in the forth thematic area, whereas [1], [2] and [6] are devoted to the fifth area.

The main results obtained in the first thematic area include the description of possible tropical limits of hyperbolic amoebas of curves in terms of hyperbolic spherical complexes and obtaining a formula for the corresponding phase-valuation. In the second thematic area the candidate and his collaborators reported on a discovery of a continuous model demonstrating a self-organized criticality. It is shown that the relaxation process in the tropical sandpile model in the lowest dimension is finite. In the third area the candidate presents a treatment of planar tropical optics, accentuating wave fronts, their relation to toric surfaces with mild singularities, proves a version of Huygens principle and clarifies the interplay of continued fractions and tropical trigonometry. The main object of interest concerning the forth thematic are is the extended sandpile model. By allowing the recurrent states to have real values at vertices near the boundary of the domain on the lattice one obtains a tropical Abelian variety whose set of integer points is the original sandpile group. By investigating the one-dimensional situation of the functoriality for the extended sandpile group and its possible failure for the usual sandpile group the candidate and his collaborators show that there is a monomorphisms (and via Pontryagin duality, epimorphisms) of the usual sandpile groups of the domains which are related by a certain type of tilings. In the fifth thematic are the candidate in collaboration with Sergei Duzhin undertakes the task of computing the HOMFLY-PT polynomial of all rational knots. Furthermore in collaboration with E. Yakaboylu the candidate presents an approach to interacting quantum many-body systems based on the notion of quantum groups. In particular, it is shown that if the symmetry of a free
quantum particle corresponds to a Lie group, in the presence of a many-body environment this particle can be described by a deformed group. The quality and the quantity of the scientific research of Mikhail Shkolnikov are in accordance to the requirements imposed by the Bulgarian Law, and respectively by the additional requirements of the Bulgarian Academy of Sciences, for assumption of the academic position of associate professor.

Critique and Recommendations

I would like to share my impression that the CVs that various candidates (including Dr. Shkolnikov) submit for academic position competitions at the Institute of Mathematics and Informatics are often schematic, superficial, and lacking essential information. For example, Dr. Shkolnikov's CV lacks information regarding his professional activities for the period 2020-2023. It doesn't mention the name of his academic supervisor or the topic of either his diploma thesis or his doctoral dissertation.

Conclusion about the Candidate

Having read the documents submitted by Mikhail Shkolnikov for the competition, and based on the analysis of their importance and the research advancements of the candidate, I confirm that the scientific achievements of scientific satisfy the requirements of the Bulgarian Law, as well as the Regiments of the Bulgarian Academy of Sciences, for promotion to the academic position of a Professor in the Scientific Area of Natural Sciences, Mathematics and Informatics, and Professional Direction of the competition, 4.5. Mathematics, scientific specialty Geometry and topology (Tropical geometry).

I recommend approving the application of Mikhail Shkolnikov, PhD, for the position.

Date: 20.03.2025 Member of SC:

(Ivan Minchev)