R E V I E W

on the competition for academic position "Associate Professor"
in professional field 4.5. Mathematics, scientific specialty "Geometry and Topology",
for the needs of the Institute of Mathematics and Informatics
at the Bulgarian Academy of Sciences,
announced in SG, issue 106/ 17.12.2024

This report is prepared by **Prof. Ludmil Katzarkov** from the Institute of Mathematics and Informatics at the Bulgarian Academy of Sciences, as a member of the Scientific Jury.

Only one applicant has submitted documents for participation in the announced competition: **Mikhail Shkolnikov**, **PhD**, currently a researcher at the Institute of Mathematics and Informatics at the Bulgarian Academy of Sciences.

I. Analysis of the applicant's career profile

According to the submitted CV, the applicant received his PhD at the University of Geneva. He is the best student of G. Mikhalkin - the creator of tropical Geometry. Shkolnikov comes from an amazing linege of Richlin's students including Gromov, Eliashberg, Viro, Perelman. After finishing his PhD, Shkolnikov was a postdoc in the Institute of Science and Technology (IST), Austria and the University of Geneva, Switzerland. In the last year and a half, Misha Shkolnikov was working in the Institute of Mathematics and Informatics in Sofia as a researcher supported by Simons Foundation.

II. Evaluation of the scientific papers of the applicant for the overall academic development

Dr. Shkolnikov's research interests range from the elegant structures of tropical geometry to the complex dynamics of sandpile models and the intricacies of knot theory. Tropical geometry was introduced by G. Mikhalkin and Shkolnikov played leading role in its developments. This is a revolutionary direction in Mathematics reducing involved theory of

algebraic cycles to basic topology and combinatorics. This is the most promissing approach to the Hodge Conjecture. Shkolnikov's work not only advances these fields but also opens new pathways for future inquiry.

Let me mention several key publications by Mikhail Shkolnikov, which I have carefully studied and which have an outstanding scientific contribution:

1. *Self-Organized Criticality and Pattern Emergence through the Lens of Tropical Geometry* (2018) – Published in the Proceedings of the National Academy of Sciences, this paper introduces a novel geometric model of self-organized criticality using tropical geometry, connecting pattern formation to algebraic structures. This paper is a revolutionary. I know E. Witten likes it a lot and thinks it is breakthrough. I know that Shkolnikov played a major role in writing this paper.

2. *Tropical Curves in Sandpiles* (2016) – Featured in Comptes Rendus Mathématique, this work explores the connection between tropical geometry and sandpile models, providing insights into the combinatorial structures of sandpile dynamics.

3. *Harmonic Dynamics of the Abelian Sandpile* (2019) – Appearing in the Proceedings of the National Academy of Sciences, this study analyzes the evolution of the sandpile identity under harmonic dynamics, offering new perspectives on self-organized criticality. This is a breakthrough paper written mainly by Shkolnikov. It geometrizes many cutting edge discoveries in the area of self-organized criticality.

4. *Non-commutative amoebas* (2022) - Published in Bulletin of the London Mathematical Society, this paper initiates the study of tropical geometry beyond the case of a commutative algebraic torus, establishing, among other things, the tropical compactness theorem for tropical limits of curves in PSL(2,C).

5. In adition, Shkolnikov is also working on a paper related to "*Hyperbolic Amoebas, Spherical Coamoebas, and Radial Degenerations*" developing tropical techniques in Symplectic Field Theory. This engagement underscores his active contribution to contemporary mathematical discourse.

All these papers demonstarte immense vesatility of Shkolnikov. His research covers the following areas: Topology, Dymanical systems, Algebraic geometry, Quantum Field theory, Symplectic Field theory, Big Data Managements, Combinatorics.

III. Reflections of the applicant's publications.

According to the documents submitted by the applicant he has publications mainly in prestigious foreign journals with high impact-factor. The publication in PNAS is exceptional.

According to the presented list of publications, Mikhail Shkolnikov applies in the current competition for the academic position "Associate Professor" with **13** scientific publications. All of them were published in the period 2014 - 2024. The publications can be classified according to the place of publishing as follows: **10** papers in journals with impact factor, **5** of which belong to quartile **Q1**, **3** papers in journals indexed in Scopus.

IV. Evaluation of the teaching activities of the applicant.

The applicant has done some teaching in Switzerland.

V. Critical remarks and recommendations

have no remarks to the documentation presented for the competition. The documents and necessary references submitted by the applicant are prepared precisely and meet the requirements,

VI. Overall evaluation of the application

After my careful and critical reading of the documentation and the publications presented for the competition and my analysis of their significance, I confirm that the scientific contributions of Mikhail Shkolnikov meet the minimal national requirements of the Act on Development of the Academic Staff in the Republic of Bulgaria, the Regulations for its application, and the Rules for the conditions and regulations for acquiring scientific degrees and occupying academic positions in the Institute of Mathematics and Informatics at the Bulgarian Academy of Sciences for occupying the academic position **"Associate Professor"**.

VII. CONCLUSION

Based on the above, I give my **positive evaluation** for the application and recommend **Mikhail Shkolnikov** for the **Associate professor** position in the Institute of Mathematics and Informatics most enthusiastically in the highest possible terms. The presence of Dr. Shkolnikov at our institute reflects our commitment to excellence and innovation in mathematical research and education.

March 21, 2025 Reviewer:.....

(Prof. Ludmil Katzarkov)