

# REPORT

by Prof. Dr.Math.Sci. Peter Boyvalenkov

Competition for the academic position Associate Professor in the professional field 4 Natural Sciences, Mathematica and Informatics, professional direction 4.5 Mathematics (combinatorics, graph theory), announced in State Gazette No. 14/10.02.2023 by Institute of Mathematics and Informatics, BAS

**1. Competition information.** The competition is announced by IMI-BAS on 10.02.2023 г. Within the deadline, documents are submitted by one candidate – Danila Dmitrievich Cherkashin, a postdoc in IMI-BAS. The set of documents is complete. The Scientific Jury for the competition is appointed with order 185/07.04.2023 of the Director of IMI.

**2. Candidate information.** Danila Cherkashin has completed higher education (MS) in 2015 in Sankt Petersburg State University with diploma work “Weak forms of shadowing in topological dynamics” under the supervision of prof. S. Krizhevich. He has defended a PhD dissertation entitled “Extrema problems in hypergraph coloring” under the supervision of prof. A. Raigorodskii and prof. F. Petrov in 2018 in the Sankt Petersburg’s division of Steklov Institute of Mathematics of RAS, as the diploma is recognized in BAS and registered in NACID. Cherkashin worked as researcher in Sankt Petersburg State University (2015-2022), Moscow Institute of Physics and Technology (2016-2021) and Sankt Petersburg’s division of Steklov Institute of Mathematics of RAS (2021-2022); some of these positions are part-time. Since July 2022 he is a postdoc in IMI-BAS.

**3. General description of the presented papers.** The candidate presents 11 papers for the competition. The reference list for complying with the minimal requirements for associate professor in IMI-BAS is filed with these 11 papers. It is seen that 10 of these papers have impact factors (2 in Q1, 3 in Q2, 4 in Q3, and 1 in Q4), the eleventh has an SJR, and the remaining are reviewed/indexed in MR and Zbl. As far as I know (and there are no signs for the opposite), these papers are not used in other procedures under LDASB (ZRASB) of the candidate. I accept for evaluation all presented 11 papers.

**4. Scientific contributions.** The scientific interests of Danila Cherkashin are in the field of Combinatorics and Graph theory, more concretely in hypergraph coloring and chromatic numbers of some spaces.

The papers [5-9], presented for the competition, belong to the first area and the papers [2-4,10-11] – to the second (we will use the numbering from the list of publications which is different than this in the contributions' reference).

The papers of the candidate on hypergraph coloring are, in a sense, continuation of the research from his PhD dissertation. Let  $m(n,r)$  be the minimum edges in an  $n$ -homogeneous hypergraph whose vertices cannot be properly colored in  $r$  colors (a coloring of a hypergraph is called proper if there are no edges connecting vertices of the same color). It is proved in the paper [8] that for fixed  $n$  the value of the quantity  $m(n, r)/r^n$  for  $r$  tending to infinity has a limit  $L_n$ . This proves a conjecture of Noga Alon from 1985, which itself is a significant achievement. Similar result is obtained in the case of list colorings. In the paper [7] the case  $n=3$  is considered and estimates for the bound  $L_3$  are obtained. Let  $f(n)$  be the minimum number of the edges in an  $n$ -homogeneous hypergraph whose vertices cannot be colored in two colors in such a way that any edge is incident with exactly  $n/2$  vertices of the same color. In [5], an upper bound for  $f(n)$  is obtained and it is better than the best known at that time (obtained by Alon, Kleitman, Pomerance, Saks, and Seymour in 1987). In the paper [6] a construction based on hypergraphs of high discrepancy is proposed to lead to proper coloring of Kneser graph  $K(n, n/2-t, s)$  with  $(4+o(1))(s+t)^2$  colors. In [9], a survey of the most important results in extremal problems from hypergraph coloring from the last years is presented.

Let  $M$  be a metric space (often,  $M$  is a subset of Euclidean space) and  $G$  be the graph with vertices the points of  $M$  and edges connecting vertices at distance 1 apart. The chromatic number of  $G$  is also called chromatic number of  $M$  and is denoted by  $\chi(M)$ . In [3], it is proved that  $\chi(R^2 \times [0, \varepsilon]^2) \geq 6$  for every positive  $\varepsilon$ . In the papers [2] and [4] improvements of the lower bounds for  $\chi(R^n)$  for  $n$  between 9 and 12 are obtained. In [10] new lower bounds for the chromatic numbers  $\chi(R^n)$  and  $\chi(Q^n)$  for some small values of  $n$  are obtained. In the paper [11] the chromatic number of spaces  $R^n \times [0, \varepsilon]^k$  is considered and it is proved that  $6 \leq \chi(R^2 \times [0, \varepsilon]^2) \leq 7$  for small enough  $\varepsilon > 0$ .

In [1], it is proved that for every dynamic system (a pair of a compact metric space and a continuous map) every pseudotrajectory with small enough errors contains a subsequence of positive density which is pointwise close to an exact subsequence with the same indexes.

**5. Approbation of the scientific contributions.** There are 30 citations of the papers for the competition (self-citations excluded) in the NACID reference but this is not a complete list. The data in Scopus is incorrectly higher (this is error by the Scopus itself) but my evaluation shows over 100 citations in total (May 2023; self-citations excluded). MathSciNet shows 19 indexed papers and 100 citations (self-citations included). During the last year results were presented by talks at the Spring conference of UBM (by invitation), at the national seminar on Coding theory and at seminars in IMI. I will also note the activity in the work with students since his arrival in Bulgaria.

**6. Teaching and project participation.** In the period 2016-2020 the candidate has participated in three projects of the Russian NSF valued at 120 mn rubles (about 2.7 mn leva). Since February 2023 he is a postdoc under Scientific programme PIKOM by IMI and FMI-SU (i.e. participant in the Programme). By the documents presented it is not explicit about teaching activities but I found information about 70 hours exercises in NRU VSE. In Bulgaria, Cherkashin takes part in the work with gifted students as he participates in the preparation of different national teams.

My personal impressions from the work of Danila Cherkashin are excellent. He is strongly involved in his research with high productivity and will be definitely very useful for IMI-BAS as a habilitated scientist.

**7. Conclusion.** My conclusions, based on the documents presented by the candidate, and presented above, as well as the fact that they fulfill the minimal national requirements and these of BAS and IMI-BAS **allow me to propose Danila Dmitrievich Cherkashin to be elected for the academic position „Associate Professor” in scientific area 4. „Natural sciences, mathematics and informatics”, professional area 4.5 „Mathematics” (Combinatorics, Graph theory).**

Sofia, 23.05.2023

Signature:

Prof. DrSci Peter Boyvalenkov