

STATEMENT

**on the procedure for attaining a scientific degree “Doctor of Sciences”
in scientific area 4. Natural Sciences, Mathematics, and Informatics,
professional field 4.5 Mathematics (Mathematical Logic),
Faculty of Mathematics and Informatics,
at Sofia University “St. Kliment Ohridski” (SU).**

This statement is written and submitted by Assoc. Prof. Trifon Anchev Trifonov — FMI, professional field 4.6. Informatics and Computer Science (Programming), appointed to the academic jury for this procedure by the Rector of SU in accordance with Order ПД-38-613/21.12.2020.

1. General Description of the Dissertation and the Submitted Documents

The documents submitted by the candidate are in full compliance with the requirements of the Academic Staff Development Act (ZRASRB), the Regulations Act for the Implementation of ZRASRB (PPZRASRB), and the Regulations Act about the Terms and Conditions for Acquisition of Academic Degrees and Occupation of Academic Positions at SU (PURPNSZADSU).

The submitted dissertation has a total of 270 pages and consists of 7 chapters and a bibliography. The text is written in English and contains a total of 162 references.

The dissertation thesis is well structured. The distinct topics addressed in it are clearly differentiated and their presentation is consistent. The introductions to each of the chapters provide a clear account of the historical context of each of the problems, which motivates the questions being considered and aids the evaluation of the candidate’s contributions. The multitude of citations and references to previous results speak of the close familiarity of Prof. Alexandra Soskova with the respective scientific areas. Their presentation provides a fascinating narrative of the development of the scientific research of each of the topics on a global scale. The introductory first chapters present an excellent overview of the diverse results in the dissertation thesis under the unifying framework of Computable Model Theory.

For the purposes of the procedure Prof. Alexandra Andreeva Soskova has presented a total of 10 titles, including 10 publications in domestic and international scientific issues and conferences.

The candidate has submitted a total of 2 additional documents supporting the professional achievements.

The additional documents consist of two positive reports on the candidate’s dissertation thesis. The first report is from Acad. Sergey Goncharov, Director of the Sobolev Institute of Mathematics, Novosibirsk, Russia. It contains a thorough review of the results in the dissertation thesis and states that Prof. Alexandra Soskova has obtained significant and recognized results in her field. The second report is by Prof. Antonio Montalban of University of California, Berkeley. It focuses on the importance of the results described in the dissertation thesis in the context of the scientific work of the report’s author. The review emphasizes the qualities of the dissertation as being a faithful summary of the scientific work of Prof. Alexandra Soskova.

2. Data and Personal Impressions of the Candidate

Prof. Alexandra Andreeva Soskova is an established lecturer at FMI of SU of 10 courses in BSc and MSc programmes, as well as the head of the Master of Science program “Logic and algorithms”. She graduated MSc in Mathematical Logic in 1979 and successfully defended her doctoral thesis in 1990, after which she started work at FMI of SU as a researcher, later acquiring a position of Assistant Professor (in 1993), Associate Professor (in 2005), and Professor (in 2019). Prof. Alexandra Andreeva Soskova is among the most notable and active members of the Mathematical Logic group at SU with over 30 publications in her field of studies, participant in over 10 projects, and annual visits in universities and scientific research centres abroad. Her international recognition as a scientist and specialist in her field is evidenced by her participation in editorial boards, as well as in programme and organizing committees of several domestic and international conferences.

I know Prof. Alexandra Soskova since 2001, when she was teaching classes at the elective course of Mathematical Logic, which greatly influenced my scientific interests and my professional development. I have extremely positive impressions from Prof. Alexandra Soskova, both as a lecturer and as a colleague. Her brisk mind and in-depth reasoning, the ease with which she presented complicated results, and her friendly character have made a significant impact on me. I served as a reviewer on four projects supervised by Prof. Alexandra Soskova and financed by the Scientific Research Fund of SU, which is how I am acquainted with her scientific work and its development in the past few years. These projects’ objectives included not only solving specific scientific problems in the candidate’s research field, but also the development of doctoral students and young scientists at the Logic group in Sofia. I see this as a testament to the commitment of Prof. Alexandra Soskova to aid the scientific and academic development of young colleagues.

3. Analysis of the Content of the Theoretical and Applied Contributions Described in the Submitted Publications

The scientific work of Prof. Alexandra Soskova is focused almost entirely on Computability Theory, and, more precisely, on Degree Theory and Effective Model Theory. The research group in Computability Theory at Sofia, which the candidate is part of, has well-established traditions in this scientific field and has a long-standing active and fruitful participation in international scientific research groups. I am familiar, albeit not in details, with the group’s research, in particular with Prof. Alexandra Soskova’s work in my role as a reviewer of scientific projects lead by her and a juror in the competition on which she was appointed at the position of Professor.

The scientific contributions are clearly noted in the provided autoreferate. They are theoretical in nature and have theoretical applications in Computable Model Theory. The main contributions of the dissertation thesis may be summarized as follows:

- (a) **definition of “jump of a structure” and proof of the Jump Inversion Theorem:**
 - the notion is analogous to the classical notion “jump of a degree”, the theorem is proved in a generalized and relativized form and some of its applications for generalizing other theorems in Computability Theory are presented;
- (b) **criteria for admission of strong jump inversion:**
 - the criteria are natural and convenient and it is shown how they can be applied to improve previous results;
- (c) **positive and negative examples of classes of structure with efficient interpretations:**

- it is shown that a classical effective embedding of graphs in linear orders cannot be effectively decoded;
 - an embedding of a field in its Heisenberg group with effective decoding is shown, improving on a previous results, together with a general technique for elimination of parameters in an efficient decoding;
- (d) **examples of the independence of the isomorphic equivalence of linear orders and the isomorphic equivalence of their cohesive powers**¹
- the order types of the cohesive powers of computable copies of ω have been determined under various conditions and the cohesive powers of other linear orders are studied;
- (e) **definition of variants of the notion “cototal enumeration degree” and study of their properties:**
- multiple examples are provided for cototal sets and degrees, including ones demonstrating the strict inclusion of the notions “weakly cototal”, “cototal” and “graph-cototal”;
 - a “skip” operator characterizing cototality is defined and a skip inversion theorem is proved along with other interesting properties.

I find the scientific contributions to be original and significant, which is confirmed by the respective publications in journals with high impact factor. Additionally, three of the publications [1,3,10] have many citations from different authors, which is a testament of scientific interest towards the results.

4. General Evaluation of Scientific Work and Professional Achievements

With the exception of the first two chapters providing, respectively, an introduction into the problem area and preliminary definitions and statements, the remaining chapters are substantially based on the publications presented by the candidate. Section 5.4 is an exception, being based on a yet unpublished collaborative work of the candidate in conjunction with three other authors (cited as [AKMS]). Below is a summary of the presented publications, in order of their appearance in the dissertation thesis:

Chapter 3 combines publications [1–4], which chronologically develop the concept of “jump of a structure”, the jump inversion theorem and its applications, as follows:

- Sections 3.2 and 3.3: following the presentation in [1] and [2], whereas in [1] the definition is given via a jump spectrum, while in the collaborative work [2] the definition is generalized to abstract structures via a Moschovakis extension;
- Section 3.1: the applied Moschovakis extension is described in [3];
- Section 3.4: the applications are described in [4];

Chapter 4 completely follows the presentation in [5];

Chapter 5 contains results described in [6] (Section 5.1 and 5.2) and [7] (Section 5.3);

Chapter 6 encompasses the publications [8] (Sections 6.1 and 6.2) and [9] (Sections from 6.3 through 6.6);

Chapter 7 completely follows the presentation in [10].

The scientific metrics of the publications are as follows:

¹Meaning that neither equivalence implies the other.

- 4 papers in journals with Impact Factor: Transactions of the American Mathematical Society, Journal of Symbolic Logic, Journal of Logic and Computation [3,5,6,10];
- 2 papers in the journal Lecture Notes in Computer Science with SJR [1,8];
- 2 papers in the proceedings of the Panhellenic Logic Symposium [2,4];
- 2 submitted papers [7,9].

With the exception of [1], all other publications are collaborative works, most of them in a broad group, whereas the candidate has specifically declared that all collaborators have equal contributions. After a subsequent inquiry, Prof. Alexandra Soskova provided me with a verbal and detailed account of how the research and preparation of each of the publications and clarified the individual contribution of each author. I was convinced that each of the cases involved true collaborative research work, in which it is impossible to fully, clearly, and objectively discern the individual contributions of any of the authors. I furthermore believe that the contribution of each of the authors was significant and believe it can be fairly considered as equal.

From all presented publications only [6,8,10] are counted towards the minimal required conditions for this procedure, and they have not been counted for the academic positions Associate Professor or Professor.

Based on the provided citations report:

- papers [1] и [3], whose main result is the inversion jump theorem for degree spectra, has most noted citations: 11 and 25, correspondingly (self-citations excluded), from a large variety of citing authors;
- paper [10] has 10 reported citations by different authors, which is impressive considering that the paper was published in 2019;
- papers [5] and [6] have one reported citation each.

After a detailed review I confirm that:

- a) the submitted publications are in full compliance with the minimal national requirements under Art. 2b (2) and (3) of ZRASRB, Section III and Appendix to Art. 1a (1) of PPZRASRB as well as with the additional requirements in PURPNSZADSU;
- b) none of the submitted publications have been submitted in a preceding procedure for acquiring a scientific degree;
- c) there is no lawful evidence for plagiarism in the submitted publications.

5. Qualities of the Autoreferate

An autoreferate is provided in both Bulgarian and English, and I have not detected any significant difference between the two versions. Its presentation follows the structure and the numbering of the dissertation thesis, which significantly simplifies the transition between the two texts. The introductory chapter provides an extremely helpful and informative review of the problem area, and also clearly and objectively summarizes the candidate's contributions in the context of other research work. The scientific metrics of the presented publications are also included. The remaining chapters of the autoreferate are essentially shortened variants of the corresponding chapters in the dissertation thesis, where proofs and some complementary arguments and remarks are omitted. I regard the autoreferate as correctly representing the results and the contents of the dissertation thesis.

6. Critical Remarks and Recommendations

I have the following remarks and recommendations:

- it would be convenient for the reviewers if the ideas and contributions that can be objectively assigned exclusively to the candidate were clearly noted, wherever possible;
- the autoreferate could be more concise, which, in my opinion, would make the candidate's own contributions more prominent;
- the proof of Lemma 7.6.7 is relatively lengthy and perhaps could be made more readable if split into more granular steps;
- some leftover occurrences from the papers may be found in the text, such as “the second author” and ”this paper”, it would be better if they were removed;
- I feel that the thesis would benefit from a concluding chapter, which summarizes all obtained results in the same context.

7. Conclusion

Based on the review of the dissertation and its accompanying scientific publications, as well as on the analysis of their significance and the theoretical and applied contributions, I hereby confirm that the scientific achievements of the candidate meet and exceed the requirements of ZRASRB, PPZRASRB, and PURPNSZADSU for acquiring a scientific degree “Doctor of Sciences” in the scientific area 4. Natural Sciences, Mathematics, and Informatics and professional field 4.5 Mathematics (Mathematical Logic). More specifically, the candidate satisfies the minimal national requirements of the professional field and no plagiarism has been detected in the submitted scientific publications submitted.

Based on the above, I hereby **recommend** to the scientific jury to award Prof. Alexandra Andreeva Soskova with a scientific degree “Doctor of Sciences” in scientific area 4. Natural Sciences, Mathematics, and Informatics, professional field 4.5 Mathematics (Mathematical Logic).

March 20, 2021

Prepared by: _____
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