

## OPINION

**related to the procedure for obtaining the scientific degree Doctor of Sciences in a professional direction 4.5. Mathematics (Mathematical Logic) for Prof. Dr. Alexandra Andreeva Soskova, Department of Mathematical Logic and Applications at FMI.**

The opinion was prepared by: Prof. Dr. of Mat. Dimitar Ivanov Vakarelov, pensioner, member of the extended staff of the Department of Mathematical Logic and Applications at the Faculty of Mathematics and Informatics of S.U. St. Kliment Ohridski in his capacity as a member of the scientific jury of the competition according to RD-38-613 / 21-12-2020 of the Rector of Sofia University.

### **I. General description of the submitted materials**

**1. Documents on the procedure.** The documents submitted under the procedure comply with the requirements of Bulgarian Law on Scientific Degrees and Titles and the Regulations on the terms and conditions for acquiring scientific degrees and holding academic positions at Sofia University "St. Kliment Ohridski ". The following documents are presented.

1. Dissertation work in English COMPUTABLE STRUCTURE THEORY: JUMP OF STRUCTURE, CODING AND DECODING
2. Abstract,
3. Information on the implementation of the minimum national requirements under Art. 2b of the Law on Natural Sciences, Mathematics and informatics, professional field 4.5 Mathematics (Mathematical logic).
4. Curriculum vitae,
5. Diploma for completed higher education,
6. Diploma for the scientific-educational degree doctor,
7. Declaration of the candidate in connection with the submitted dissertation for obtaining the scientific degree Doctor of Sciences,
8. List of citations,
9. List of publications and publications related to the dissertation,
10. Two reviews of the dissertation: by Acad. Sergei Goncharov, Siberian Department of the Russian Academy of Sciences, and by Antonio Montalban, Professor at the University of California, Berkeley.

**2. Details of the candidat .** Alexandra Andreeva Soskova was born in Sofia in 1956. She graduated with honors in mathematics at Sofia University "St. Kliment Ohridski "and a master's degree in mathematical logic in 1979 with the defense of a diploma thesis under the supervision of Prof. D. Skordev. After that she prepared a PhD thesis under his guidance and defended it in 1990. She became assistant, associate professor and professor at the Chair of mathematical logic and applications in FMI. She was for two terms head of the Department of Mathematical Logic and Applications, and also participated in the management of FMI as a deputy Dean.

### **3. General characteristics of the presented scientific works and achievements of the candidate.**

The presented dissertation (in a volume of 270 pages) is in the field of recursion theory, degrees of insolvability and effective model theory. Recursion theory has been Soskova's scientific field since the time of her master-degree dissertation ("Some Problems Related to the Definition of Simple Computability") and the subsequent dissertation ("Effective Algebraic Systems"). This is a special field "computability in algebraic systems", also called "computability in abstract structures", initiated in our country and led by Prof. Dimitar Skordev. Later, in collaboration with Ivan Soskov and his followers, the topic expanded in line with the current state of computational theory to the problems of numerical reducibility and spectra of structures used in the effective theory of models for evaluating information content and the complexity of abstract mathematical structures. This is a topic relevant in recent years and the dissertation contains the main achievements of Soskova in the field. The presented 10 articles (8 of them published in authoritative professional journals and publications, two presented for publication) cover the content of the dissertation. One of them is authored only by her name and the others are co-authored with colleagues from the department and with active foreign specialists in the field. According to a statement by Soskova, all co-authors in the publications have equal participation in the results obtained. The dissertation Abstract (in volume of 139 pages) is an abbreviated version of the dissertation and follows its structure. The quality and quantity of the results obtained by Alexandra Soskova, both individually and jointly, show that she significantly exceeds the minimum requirements of the Bulgarian Law on Scientific Degrees and Titles and the additional requirements of Sofia University "St. Kliment Ohridski" for obtaining the scientific degree Doctor of Sciences. In addition, the results obtained do not intersect with the results of her Ph.D. thesis and have little in common with the works on her competition for professor. Most of the results are quite fresh and obtained in recent years. The fact that most of the articles are joint with leading experts in the field shows of Soskova's undoubted authority among colleagues in the field. In addition, this fact demonstrates also the authority of the Bulgarian group working in this direction. 48 citations were found on the topic of the dissertation. The high quality of the results is confirmed by the two reviews of the dissertation, by Acad. Sergey Goncharov and Prof. Antonio Montalban, leading scientists in the field, who give high marks to the results of the dissertation and qualify Soskova as a leading and recognized scientist in the field. There is no "legally proven plagiarism in the scientific papers submitted at the competition", moreover, there is no doubt about such a thing.

### **4. Concrete description of the scientific achievements of the candidate contained in the materials for participation in the competition.**

The dissertation is divided into 7 chapters + literature. Chapter 1, which is an Introduction, gives a general description of the field. Chapter 2 introduces the basic concepts and methods needed for the rest of the dissertation. Chapter 3 is devoted to the important concept of "jump of a structure" initially introduced by Soskov and then undergoing various modifications and extensions. The main result is the theorem for inversion of the jump proved by Soskova in the publication 1 of the

list (which result is published in Lecture Notes in Computer Science). This theorem has received the largest number of citations. Other results of this type are published in the paper 2 (Proceeding of the 6th Panhellenic Logic Symposium), paper 3 (Journal of Logic and Computation) and paper 4 (7th Panhellenic Logic Symposium). Chapter 3 is devoted to the so-called "strict reversal of the jump of structures". Model-theoretic conditions are given for a structure to admit a strict reversal of the jump and these conditions are applied to certain classes of structures: Boolean algebras, trees, differentially closed fields. The results are published in the paper 5. Chapter 5 is entitled "Effective embeddings and interpretations" and these concepts are used to study the expressive power and the complexity of a given structure relative to another. The results of this chapter are included in the papers 6 (Journal of Symbolic) and 7 (submitted in 2020). Chapter 6 deals with computable versions of some model theoretic constructs. The so-called cohesive degrees, which generalize the concept of ultrapower, are considered. The results obtained are included in the paper 8 (Lecture Notes in Computer Science) and 9 (submitted, 2020). Chapter 7 is devoted to the concepts of co-totality and skip from the theory of numeration degrees, the results of which are included in the paper 10 (published in The Transactions of the American Mathematical Society).

**5. Critical remarks and recommendations.** I have no critical remarks and recommendations to the text of the dissertation and the presented works. I have only a critical note to the author's abstract: it is too detailed and just copies the dissertation in an abbreviated form. Its volume of 139 pages is exactly half the volume of the dissertation itself. In my opinion, more attention should have been paid to the content assessment and interpretation of the results and their place in the relevant scientific field.

**6. Personal impressions of the candidate.** I have known Alexandra Soskova since the time she started her magister study at the chair and then as a colleague. She is a warm-hearted and responsive person. After the untimely death of Ivan Soskov, the leader of the group in the theory of computability based on the theory of spectra and reducibility, she actively continued this activity, expanding cooperation with leading scientists in this field. Her active participation in international forums, holding responsible positions in international scientific organizations contributes to the authority of the Bulgarian group in the theory of computability and its recognition as one of the leading groups.

**7. Conclusion on the application.** After getting acquainted with the materials and scientific papers presented in the competition and based on the analysis of their significance and scientific contributions contained in them, I confirm that the scientific achievements meet the requirements of the of Bulgarian Law on Scientific Degrees and Titles, the Rules for its application and the relevant Rules of Sofia University " St. Kliment Ohridski " for receiving by the candidate of the scientific degree " Doctor of Mathematical Sciences " in the professional field 4.5. Mathematics (Mathematical logic). In particular, the candidate satisfies the minimum national requirements in the professional field and no plagiarism has been established in the scientific papers submitted at the competition. I give my positive assessment of the candidacy.

## **II. OVERALL CONCLUSION**

Based on the above, I recommend the esteemed scientific jury to award Prof. Alexandra Andreeva Soskova the scientific degree "Doctor of Mathematical Sciences".

Sofia 16.03.2021

Prepared the opinion:

Prof. Dr. of Mat. Sci. Dimitar Vakarelov