R E V I E W

on

the competition for academic position "Professor",

area of Higher Education: 4. Natural Sciences, Mathematics and Informatics,

professional field 4.5. Mathematics,

announced in SG, issue 63 /30.07.2021

for the needs of Sofia University "St. Kliment Ohridski",

Faculty of Mathematics and Informatics,

Department of Algebra

This report is prepared by prof. Dr. Sci. **Stefka Bouyuklieva**, FMI, St. Cyril and St. Methodius University of Veliko Tarnovo, professional field 4.5. Mathematics (Algebra and Number Theory), as a member of the Scientific Jury on this procedure according to Order № РД-38-475 / 28.09.2021 of the the Rector of Sofia University.

Only one candidate has submitted documents for participation in the announced competition:

Associate Professor PhD **Maya Miteva Stoyanova**, Faculty of Mathematics and Informatics, Sofia University "St. Kliment Ohridski".

I. General description of the presented materials

1. Details of the application.

As a member of the scientific panel, I have received all the administrative and scientific documents required by the Act on the Development of the Academic Staff in the Republic of Bulgaria (ADASRB), the Rules for its implementation and the Rules on the terms and conditions for awarding of academic degrees and occupying of academic positions at Sofia University "St. Kliment Ohridski".

For participation in the competition, the candidate Maya Miteva Stoyanova presented a list of a total of 13 titles, incl. 6 publications in scientific journals referenced in Web of Science (with impact factor IF), 2 publications in scientific journals referenced in Scopus (with impact rank SJR), 5 publications in scientific journals referenced in Web of Science (without IF), in Scopus (without SJR), in MathSciNet, in zbMATH and/or in IEEE Xplore. Additionally, a list of all the candidate's publications is attached.

Many other documents supporting the achievements of Assoc. Prof. Stoyanova are presented: reference to the scientometric indicators of the publications, author's reference, list of citations, reference for participation and management of national and international projects, as well as documents reflecting the teaching experience and PhD students. All required declarations are attached.

2. Information for the applicant.

Maya Stoyanova graduated in mathematics at Sofia University "St. Kliment Ohridski "in 1992. She acquired Master Degree with specialization Geometry and second specialty teacher of mathematics, and the title of her diploma thesis is "Geometry of a skew-symmetric operator in three-dimensional Riemannian manifold".

From 2003 to 2006 Assoc. Prof. Stoyanova was a PhD student at the Department "Mathematical Foundations of Informatics" of the Institute of Mathematics and Informatics at the Bulgarian Academy of Sciences with supervisor Prof. Peter Boyvalenkov. In 2009 she defended her dissertation titled "On the structure of some spherical codes and designs."

From 1992 to 1999 Maya Stoyanova was a part-time assistant at the Department of Geometry, and since 1999 she has been a lecturer at the Department of Algebra at FMI, Sofia University "St. Kliment Ohridski ", and since 2014 she has been an associate professor. From 2016 to 2020 she was the head of the Department of Algebra (intermittently), and since 2017 she has been the Vice Dean of FMI, initially responsible for research, projects and international activities, and currently for the academic staff of the faculty.

Assoc. Prof. Maya Stoyanova is a member of the teams of international and national research and educational projects, a member of program and organizational committees of international and national conferences and seminars. Since 2017, she has participated in the preparation of all accreditation self-assessment reports for the institutional accreditation of Sofia University "St. Kliment Ohridski" and program accreditation of the specialties in professional fields 4.5, 4.6 and 1.3 in the Faculty of Mathematics and Informatics of Sofia University, including the doctoral programs in these areas, and in the organization and conduct of the procedures in the faculty.

Maya Stoyanova has a rich scientific activity. She has co-authored 25 publications in scientific journals (one is still peer-reviewed) and 22 publications in proceedings of scientific conferences. She has presented talks at 47 national and international scientific sessions, seminars, conferences, symposia. She was the research supervisor of two successfully defended doctoral students - Tanya Marinova and Tedis Ramaj.

3. General characteristic and analysis of the scientific work and achievements of the applicant.

Assoc. Prof. Maya Stoyanova applied for the competition with 13 publications, all in English. Of these, 5 are articles in international scientific journals, two of them are publications in annual proceedings (respectively of Bulgarian Academy of Sciences and Sofia University), and 6 are included in proceedings of international conferences. The publications [1-4] are included in group B (instead of a habilitation thesis), as they carry 186 points in the table with scientometric indicators (with a required minimum of 100 points). The publications presented for indicator group D carry 276 points with a required minimum of 200 points. In general, in the table with the scientometric indicators the sum of the points according to the documents submitted by the candidate, a total of 781 points, exceeds the minimum of 550 points required by the Regulations for implementation of the Law for the development of the academic staff in Bulgaria for professional field 4.5 Mathematics.

A reference to 30 citations in papers and monographs, referenced and indexed in Web of Science and/or Scopus, and 34 other citations is presented.

All publications of Assoc. Prof. Stoyanova on the competition are joint works with different researchers. A declaration of equivalent contribution is presented for each publication. None of these publications has been used in previous procedures to obtain a degree or an academic position from the candidate. No plagiarism was found.

4. Teaching activities of the applicant

Assoc. Prof. Maya Stoyanova has a rich pedagogical biography. She worked first as a part-time assistant at the Department of Geometry, and then as a full-time assistant, senior and chief assistant, and associate professor at the Department of Algebra at FMI, Sofia University "St. Kliment Ohridski", having given lectures and exercises in almost all algebraic disciplines included in the curricula. I have no direct impressions of her work as a lecturer, but I have positive feedback from her students, who are impressed by her dedication, responsiveness and correctness.

5. Content analysis of the scientific and scientific-applied achievements of the candidate contained in the materials for participation in the competition

The scientific work of Assoc. Prof. Maya Stoyanova is in the field of Algebraic Coding Theory. The publications with which she applied for this competition refer to: (1) codes in Hamming spaces, and (2) orthogonal arrays.

(1) Codes in Hamming spaces have been considered in the publications [1], [2], [4], [7], [10] and [11]. The publications on this topic are from the last 3-4 years. Bounds for the cardinality of codes and designs with certain properties in Hamming spaces, as well as universal

bounds for the potential energy of the considered configurations are mainly studied. For this purpose, linear programming techniques are applied in the Hamming space, in which a Hamming distance and a related inner product are defined: $\langle x, y\rangle = 1 - \frac{2d(x,y)}{n}$. For a given function h: $[-1,1] \to (0, +\infty)$ the potential energy of a code $C \subset F_q^n$ is defined as

$$E_h(C) = \sum_{x,y \in C, x \neq y} h(\langle x, y\rangle).$$

Universal bounds on the energy of codes and designs in Hamming spaces that hold for a large class of potential functions, allow a unified treatment, and can be viewed as a generalization of the Levenshtein bounds for maximal codes, are obtained in [4].

Using the Delsart-Yudin method, Maya Stoyanova together with her coauthors Boyvalenkov, Dragnev, Hardin and Saff have obtained a universal lower bound for the minimum energy $E(M, N; h) \coloneqq min\{E_h(C): |C| = N\}$ for codes with a fixed cardinality, namely

$$E(M, N; h) \geq N^2(b\rho_0 h(-1) + \sum_{i=1}^{m} \rho_i h(\alpha_i)),$$

where the parameters *m*, *b=0,1*, α_i и ρ_i depend only on M and N, but not on the potential function h. Recently, the problems of obtaining and studying parameters (cardinality and energy) of codes with fixed minimum and maximum distance, as well as with fixed cardinality and minimum distance, for which it is important to obtain analogues of the classical universal bounds of Levenshtein.

In paper [1], the authors employ signed measures that are positive definite up to certain degrees to establish Levenshtein-type upper bounds on the cardinality of codes with given minimum and maximum distances, and universal lower bounds on the potential energy for codes with given maximum distance and cardinality. The distance distributions of codes that attain the bounds are found and necessary and sufficient conditions for the optimality of these bounds are derived.

In [7], a unified treatment for obtaining bounds on the potential energy of codes in the general context of polynomial metric spaces is presented. The lower bounds, that are derived via the linear programming techniques of Delsarte and Levenshtein, are universally optimal in the sense that they apply to a broad class of energy functionals and, in general, and cannot be improved for the specific subspace. Tests are presented for determining whether these universal lower bounds can be improved on larger spaces. These bounds are applicable on the Euclidean sphere, infinite projective spaces, as well as Hamming and Johnson spaces.

Publications [2], [10] and [11] present research mainly on Levenshtein bounds, extending the theory that Levenshtein introduced for obtaining bounds for the basic parameters of different types of codes and designs. In [10] new upper bounds of the same type for the cardinality of codes with a given minimum and maximum distance are obtained, as well as lower bounds for the potential energy for codes with a given maximum distance and cardinality. In the article [2] the Levenshtein bounds in q-ary Hamming spaces are improved.

(2) Orthogonal arrays are combinatorial structures that are used in many areas, mainly in experimental planning statistics, but also in Coding Theory and Cryptography, for chip testing, authentication codes, universal hash functions, threshold circuits, software testing, etc. In the joint work of Maya Stoyanova with Prof. Peter Boyvalenkov and Assoc. Prof. Hristina Kulina ([12] and [13]) the binary orthogonal arrays with parameters (τ,n,M), also called τ-designs in the binary Hamming space are considered. A method for finding all possible distance distributions for a binary orthogonal array is proposed, which is based on constraints on the distance distributions of the studied array through the associated arrays.

It should be emphasized that the knowledge of the distance distribution of an orthogonal array with respect to the points of the considered Hamming space is of great importance for the study of orthogonal arrays. The distance distribution can be obtained as a nonnegative integer solution of a system of linear equations of special type.

In [8], the authors develop and apply combinatorial algorithms for investigation of the feasible distance distributions of binary orthogonal arrays with respect to a point of the ambient binary Hamming space utilizing constraints imposed from the relations between the distance distributions of associated arrays. This turns out to be strong enough to prove the nonexistence of binary orthogonal arrays of different parameters (length, cardinality, strength). For the existing arrays this approach allows substantial reduction of the number of feasible distance distributions which could be helpful for classification results (uniqueness, for example).

Publication [3] can be considered as a continuation of [8], as the algorithm given there is further extended for the purpose of the specific study. A similar approach was used in [6] to obtain restrictions on the distance distribution of ternary orthogonal arrays. Using relations between distance distributions of arrays under consideration and their relatives the authors prove certain constraints on the distance distributions of ternary orthogonal arrays. This allows to collect rules for removing distance distributions as infeasible. The used approach allows substantial reduction of the number of feasible distance distributions for known arrays. A slightly different approach using properties of the Krawtchouk polynomials, namely

$$K_k(x;n,q)=\sum_{j=0}^{k}(-1)^j\binom{x}{j}\binom{n-x}{k-j}(q-1)^{k-j},\ \ k=0,1,\dots,n,$$

where $n \geq 0$ and $q \geq 2$ are given integers, proved by Nikolay Manev in a publication from 2020, is proposed in [5]. The properties of these polynomials allow a different representation of the system of linear equations, for which the possible distance distributions give nonnegative integer solutions.

In [9], the authors obtain analytically upper bounds for the covering radius of orthogonal arrays by investigations of the set of all feasible distance distributions of the corresponding arrays. They apply a procedure for reduction of the possible distance distributions of these orthogonal arrays to improve the bound under certain assumptions. Examples of orthogonal arrays attaining and close to the obtained bounds are shown.

Some of the presented papers have been published in reputed scientific journals such as *IEEE Transactions on Information Theory*, *Discrete Applied Mathematics*, *Designs, Codes and Cryptography* and others, and the rest have been published in proceedings of international conferences held in Bulgaria and abroad.

5. Critical remarks and recommendations

The scientific and teaching activity of Assoc. Prof. Stoyanova is at a very high level and I have no remarks on the merits.

6. Personal impressions of the candidate

I have known Maya Stoyanova since the time of her doctoral studies. I have listened to all her presentations at the ACCT (Algebraic and Combinatorial Coding Theory) and OCRT (Optimal Codes and Related Topics) conference series, as well as at the annual coding theory seminars. She is a very good lecturer, her talks are prepared precisely and presented convincingly.

Maya Stoyanova is an easy-going person who is a pleasure to communicate with, very responsive, sociable, always smiling and positive. I have excellent impressions from our meetings at various conferences and seminars, as well as from our joint work as members of the teams of several research projects.

7. Conclusion for the applicant

After my careful and critical reading of the documentation and the publications presented for the competition and my analysis of their significance and the scientific and scientific-applied contributions **I confirm** that the scientific contributions of **Assoc. Prof. Maya Miteva Stoyanova** meet the 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 occupying academic positions in Sofia University "St. Klimen Ohridski" for occupying the academic position "Professor" in the scientific area and the professional field of the competition. In particular, the applicant meets the minimal national requirements in the professional field and no plagiarism has been established in the scientific papers submitted for the competition.

I give my **positive** evaluation for the application.

II. GENERAL CONCLUSION

Based on the above, I recommend the Scientific Jury to propose to the Faculty Council of the Faculty of Mathematics and Informatics at Sofia University "St. Klimen Ohridski" to elect **Assoc. Prof. Maya Miteva Stoyanova** to occupy the academic position "Professor" in the professional field 4.5 Mathematics.

16 November 2021 Reviewer: .....

(Prof. Stefka Bouyuklieva)