Statement

by Prof. D. Sci. Geno Petkov Nikolov
FMI, Sofia University "St. Kliment Ohridski"

on the competition for occupying the academic position Professor

in professional direction 4.5 Mathematics
(Algebra, Coding Theory and Applications)
for the needs of Faculty of Mathematics and Informatics (FMI)
at Sofia University "St Kliment Ohridski"

announced in State Gasette no. 63/30.07.2021

The present Statement has been prepared by Prof. D.Sci. Geno Nikolov, FMI-SU, as a member of the Scientific Jury on the competition for occupying the Academic position Professor in the professional direction 4.5 Mathematics, scientific area Algebra, Coding Theory and Application, announced in State Gasette no. 63/30.07.2021. The Scientific Jury has been approved by Order RD 38-475/28.09.2021 of the Rector of Sofia University. For participation in the competition, the only candidate who has submitted documents is Assoc. Prof. Maya Miteva Stoyanova, PhD.

1 Data about the application

The documents submitted by the competition by the applicant comply with the requirements of ZRASRB, PPZRASRB, the Regulations on the terms and conditions for acquiring scientific degrees and for holding academic positions in Sofia University "St. Kliment Ohridski" (PURPNSZAD-SU) and the Regulations on the terms and conditions for acquisition scientific degrees and for holding academic positions in Faculty of Mathematics and Informatics at Sofia University (PURPNSZAD-FMI-SU).

The documents are regular and correctly and in full describe both the scientific and teaching activities of the applicant as well as her employment in national and international research projects.

2 Data about the applicant

The Applicant Assoc. Prof. Maya Miteva Stoyanova, PhD, graduated in 1993 with a Master's Degree in Mathematics from the Faculty of Mathematics at Sofia University "St. Kliment Ohridski" with major Geometry and a second major Teacher in Mathematics. During the period 2003 –2006 Maya Stoyanova was a PhD student at the Institute of Mathematics and Informatics of BAS in Section "Mathematical base of Informatics" under the supervision of Prof. Peter Boyvalenkov. In 2009 she acquired PhD Degree with a PhD Thesis entitled "On the structure of certain codes and designs".

During the period 1992–1999 Maya Stoyanova worked as a School Teacher and, simultaneously, as a part time Assistant in FMI –SU. Since 1999 she has been permanently working at Department of Algebra of FMI–SU initially as Assistant (1999–2005), Chief Assistant (2005–2009), and in 2014 she was promoted to Associate Professor.

Dr. Stoyanova has occupied the administrative positions Head of Department of Algebra in FMI–SU (2016–2020) and Vice-Dean of FMI–SU responsible for Research and Project Activity, International Partnership and PhD Students (2017–2019). At present, she is a Vice-Dean of FMI–SU responsible for Academic Staff.

3 General characteristics of applicant's publications

The applicant Dr. Stoyanova have submitted a list with 13 of her publications for participation in the competition, which have not been submitted to preceding promotion procedures. In fact, 11 of these publication date from the period 2017 – 2021, i.e., after applicant's habilitation.

Since all submitted publications are with more than one author, the Applicant has deposed declarations of her co-authors certifying equal contribution in the joint papers. Among them, six papers are published in journals indexed in Web of Science (with IF): *"Analysis and Mathematical Physics"*, *"IEEE Transactions of Information Theory"*, *"Designs, Codes and Criptography"*, *"Discrete Applied Mathematics"*, *"Problems in Information Transmission"* and *"Comptes Rendus l'Académie bulgare des Sciences"*. Two of the papers from the list are in published in journals indexed in Scopus (with SJR), the remaining papers from the list are indexed in other systems (without IF and SJR) .

Dr. Stoyanova also has submitted a list of 12 papers indexed in Scopus and one paper indexed in Web of Science, which cite her papers.

The materials and documents presented in the competition convince that the applicant meets the minimum requirements for scientific research for acquiring the academic position of Professor in the professional field 4.5. Mathematics, as shown in the table:

Group of indicators	Applicant's points	Required
A	50	50
B	186	100
Г	276	200
Д	104	100
Е	165	100
Total:	781	550

4 Description and assessment of applicant's publications

Dr. Maya Stoyanova is a representative of the Bulgarian school in Coding Theory founded by the late Prof. Stefan Dodunekov. Thanks to the active work of Dodunekov's disciples and followers this school has earned recognition and high reputation.

According to their subject the 13 papers of the applicant submitted for the competition may be distributed into two groups:

1. **Codes in Hamming spaces.** In this group are papers [1], [2], [4], [7], [10] and [11] (the enumeration is as in list 10B of Applicant's documents).

2. **Spectra of orthogonal arrays.** This group contains the remaining seven papers from the list.

Below is a brief description of the objects of these publications.

Given natural n, $q \geq 2$, the Hamming space $H(n,q)$ is the set of all vectors $\mathbf{x} = (x_1, x_2, \ldots, x_n)$ with coordinates x_i in the alphabet $Q = \{0, 1, \ldots, q-1\}$. The Hamming distance $d(\mathbf{x}, \mathbf{y})$ between vectors $\mathbf{x}, \mathbf{y} \in H(n,q)$ equals the number of different coordinates in $\mathbf{x}$ and $\mathbf{y}$). A convenient equivalent characteristics is the inner product $\langle \mathbf{x}, \mathbf{y} \rangle = 1 - 2d(\mathbf{x}, \mathbf{y})/n$, which brings Hamming distances to inner products with values in the set $T_n = \{t_i = -1 + 2i/n \ : \ i = 0, 1, \ldots, n\}$, and makes $H(n,q)$ a polynomial metric space. A *code* C is any non-empty subset of $H(n,q)$. Important characteristics of a code C are its *cardinality* $|C|$ and the minimal and the maximal distance between elements of code.

Every function (*potential*) $h : [-1,1] \mapsto (0, \infty)$ defines the *h-energy of code* C by

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

A suitable assumption for potentials is the one of absolute monotonicity (meaning that they possess derivatives of all orders and they are positive in $[-1,1]$).

Closely related to codes are *designs*. Given natural τ and λ, *τ-design $C \subset H(n,q)$ with strength τ and index λ* is called a code $C \subset H(n,q)$ with cardinality $|C| = M = \lambda/q^\tau$, such that the $M \times n$ table (matrix) with rows the codewords of C obeys the property: every $M \times \tau$ submatrix of this matrix contains every element of $H(\tau, q)$ exactly $\lambda = \frac{M}{q^\tau}$ times. Such tables are also called *orthogonal arrays (OA) of cardinality $|C| = M = \lambda/q^\tau$, length n, q levels, strength τ and index λ*. Customary notations used for τ-designs and orthogonal arrays with such parameters are (n, M, q, τ) и $OA(M, n, q, \tau)$.

Classical problems in coding theory are, for given length and minimal distance (i.e. maximal inner product), to find the maximal cardinality of a code and the minimal cardinality of a design in a Hamming space. The first explicit bounds for designs are due to Rao (1947). Finding the value of energy of codes and designs or (most often) upper and lower bounds for this energy, obtaining codes with minimal energy are another fundamental problems in coding theory. A basic instrument for obtaining such bounds is the linear programming (LP) method. The LP method was applied for the first time in such kind of problems by Delsarte (1973). During the nineties of the last century Levenshtein developed a theory for obtaining of universal upper bounds for the energy of codes based on the LP method.

In the papers [1], [2], [4], [7], [10] and [11] Dr. Maya Stoyanova and her co-authors refine and develop further these methods, thus obtaining new estimates for cardinalities and energies of codes with prescribed parameters, demonstrate that their estimates are superior to the existing ones, prove optimality and universality of certain of the bounds they obtained and point out to situations in which these bounds are attained.

The publications in the second group ([3], [5], [6], [8], [9], [12] and [13]) are devoted to the investigation of orthogonal arrays (OA). By exploiting some combinatorial properties of OA, considered as τ-designs, in these papers the authors establish certain connections between the spectrum of a given orthogonal array and the spectra of some related OA, eventually proving nonexistence of certain binary and ternary orthogonal arrays of given type or discover restrictions for the structure of other presumably existing OA.

In my opinion, the results obtained by the applicant in the papers submitted for the competition are interesting and contribute to enriching the coding theory. While this contribution has mainly theoretical character, some of results could find applications in cryptography, computer science and in planning experiments in statistics.

For obtaining these results the author has utilized diverse mathematical tools including: signed measures that are positive definite up to certain degree, Levenshtein quadrature formulae (which in fact are Gauss-type quadrature formulae used for the estimation of one-sided L_1 polynomial approximation to functions with sign-consistent derivatives), classical orthogonal polynomials (of Jacobi and, in particular, Gegenbauer), discrete orthogonal poolynomials (e.g., of Krawtchouk) and their adjacent, etc. Implementation of such techniques is typical for specialists in approximation theory and orthogonal polynomials. The collaboration of Dr. Maya Stoyanova with leading mathematicians in coding theory such as S. Saff, P. Boyvalenkov, P. Dragnev, D. Hardin, D. Danev and others certifies that she is a recognized specialist in this field.

5 Teaching experience of the applicant

Dr. Maya Stoyanova has proven a lot of teaching experience as she has been working in the Department of Algebra of Faculty of Mathematics and Informatics (FMI) at Sofia University for more than 22 years, nearly 8 of them as Associate Professor. As an Assistant she has run seminars in all courses conducted by Department of Algebra in FMI. At present Associate Professor Maya Stoyanova reads mandatory courses in Algebra, Linear Algebra and Higher Algebra for students in the Bachelor programs of FMI. She read the specialized course "Spherical Codes and Designs. Orthogonal Arrays", split subsequently into two specialized courses "Codes and Designs in Polynomial Metric Spaces" Parts One and Two, which have been read by Dr. Stoyanova for students from Master Programs Algebra and Topology and Discrete Algebraic Structures as well as for Bachelor Degree students in FMI. She also reads jointly with Associate Prof. Silvia Boumova the specialized courses "Selected Chapters in Algebra" Parts One and Two. The lecture notes of Dr. Stoyanova have been prepared in electronic format and are available in Internet through Moodle.

Dr. Stoyanova has supervised two PhD students (one of them jointly with Dr. Boumova), who have defended PhD Theses in Coding Theory.

6 Research and project activity of the applicant

The complete list of applicant's publications consists of 24 papers in journals, 22 papers in conference proceedings, and one submitted paper. The applicant has found 64 citations of her works, 30 of which in papers and monographs indexed in Web of Science and/or Scopus, and 34 citation in other systems. Her Hirsh index (h-index) is 5 in both Web of Science and Scopus

Dr. Stoyanova has participated and presented her scientific achievements at 47 national and international forums in Russia, Italy, Austria, USA, China, Cuba, Spain, Hungary, Sweden, Germany, etc. She has been a member of Program or/and Scientific Committees of many conferences as well as a visiting scientist and lecturer in scientific and university centers in Sweden, USA and Austria.

Dr. Stoyanova has been employed in 8 national projects and programs with two of them still in progress. She has been coordinator of two projects and a member of the team of 8 other projects supported by the Sofia University Research Fund. She acted as a coordinator of the international project "Minimum Energy and Extremal Problems in Coding Theory" within the Research in Pairs Program of the Mathematical Research Institute in Obervolfach, Germany.

7 Personal Impressions

I know personally Maya Stoyanova for nearly 20 years and highly appreciate her merits of diligence, ethics in the relations with colleagues and students and responsibility to her pursuits as lecturer, researcher and deputy dean.

8 Conclusion

After reviewing the materials presented for the competition by Associate Professor Dr. Maya Stoyanova, I certify that her scientific production and teaching experience comply with the requirements of ZRASRB, PPZRASRB, and the Regulations of Sofia University "St. Kliment Ohridski" (PURPNSZAD-SU) on the terms and conditions for acquiring the scientific degree Professor in Area of Higher Education *4. Natural Sciences, Mathematics and Informatics*, Professional Direction *4.5 Mathematics* (Algebra, Coding Theory and Applications) . In particular, the Applicant meets the national minimum requirements for scientific research for the academic position Professor in the professional field 4.5. Mathematics, and I did not find any plagiarism in the scientific publications submitted for the competition. For this reason, my final overall assessment of the application **is positive.**

Based on what has been said above, I recommend to the Scientific Jury to prepare a report-proposal to the Scientific Council of the Faculty of Mathematics and Informatics at Sofia University "St. Kliment Ohridski" to elect Associate Professor PhD Maya Miteva Stoyanova for the academic position „Professor" in Professional Direction *4.5 Mathematics* (Algebra, Coding Theory and Applications).

November 18, 2021
Sofia

Prepared by Prof. D. Sci. Geno Nikolov