Review

by competition for an academic position8 "Professor"

in professional direction 4.5 Mathematics (Finite geometries) for the needs of

Sofia University "St. Kliment Ohridski" (SU),

Faculty of Mathematics and Informatics (FMI),

announced in SG No. 67 of 04.08.2023 and on the FMI and SU websites

The review is prepared by: Prof. Ph.D. Nikola Petkov Zyapkov, Shumen University "Ep. Konstantin Preslavsky".

As a member of the scientific jury in my capacity in **professional direction 4.5 Mathematics (Finite geometries)** in the competition according to Order No. RD 38-576/05.10.2023 of the Rector of Sofia University.

The only candidate submitted documents for participation in the announced competition

Associate Professor D.Sc. Asya Petrova Ruseva-Landzheva, FMI of SU

I. General description of the presented materials

1. Application data

The documents submitted by the candidate in the competition correspond to the requirements of the Law on the Development of the Academic Positions of the Republic of Bulgaria, Regulations for the Application of the Law on the Development of the Academic Positions of the Republic of Bulgaria and the Regulations on the Conditions and Procedures for Acquiring Scientific Degrees and Holding Academic Positions at SU "St. Kliment Ohridski". Associate Professor D.Sc. Asya Petrova Ruseva-Landzheva is presented 18 scientific publications for participation in the competition.

Eighteen in number of other documents (in the form of official notes and certificates from the employer, references and testimonials, awards and other relevant evidence) supporting the candidate's achievements are also presented.

2. Candidate details

Asya Petrova Ruseva-Deljeva is born in Sofia. In 1988 she graduated with excellent success FMI of Sofia University - Master's Degree (Specialization in Geometry). Ph.D. student is at IMI of BAS from 2001 to 2004, where in 2005 she successfully defended her dissertation on "Arches in Extreme Projecting Geometries and their application in the theory of encoding" for the Ph.D.

3. General characteristics of the scientific works and achievements of the candidate

The candidate is presented the articles in a group of indicators B: Ivan Landjev, Assia Rousseva, Leo Storme, On the Extendability of Quasidivisible Griesmer Arcs, Designs, Codes and Cryptography, vol:79, issue:3, 2016, pages:535-547 and Ivan Landjev , Assia Rousseva, On the Sharpness of Bruen's Bound for Intersection Sets in Desarguesian Affine Spaces, Designs, Codes and Cryptography, vol:72, 2014, pages:551-558, ISSN (print):0925-1022, ISSN (online): 1573-7586 which are published with quartile Q2. The number of points is 120 (required 100) in this group.

The candidate is presented 9 articles that they are referenced and indexed in world-famous databases with scientific information (Web of Science, Scopus and Zbl), outside of the habilitation work in a group of indicators D. The number of points is 543 (required 200) in this group.

Nineteen citations are presented in scientific publications, indexed in world-famous databases with scientific information (Web of Science and Scopus) in the group of indicators D. The number of points is 124 (required 100).

There are presented in a group of indicators E: diploma for D.Sc. - 75 points, participation in two scientific projects - 20 points and one textbook for students - 20 points. Here the number of points is 115 (required 100).

The total number of candidate's points is 952 with a minimum requirement of 550 points by area 4. Natural sciences, mathematics and informatics, 4.5. Mathematics. Associate Professor Asya Ruseva is presented complete evidence for all criteria. Therefore, Associate Professor Assya Ruseva satisfies the minimum requirements of the Law on the Development of the Academic Positions of the Republic of Bulgaria, Regulations for the Application of the Law on the Development of the Academic Positions of the Republic of Bulgaria and the Regulations on the Conditions and Procedures for Acquiring Scientific Degrees and Holding

Academic Positions at SU "St. Kliment Ohridski" for occupying the academic position of "Professor" in direction 4.5. Mathematics.

4. Characteristics and assessment of the candidate's teaching activity

The teaching activity of Associate Professor Asya Ruseva is:

Required courses, FMI, SU:

1. "Analytic geometry", specialty "Informatics"

2. "Geometry" (Basics of geometry and Projective geometry), specialty "Mathematics and informatics"

3. "Geometry" (Geometric foundations of computer graphics and differential geometry of curves and surfaces in Euclidean space), specialty "Informatics"

Elective course, FMI, SU:

"Descriptive geometry"

Detailed lectures are provided in FMI's moodle electronic environment for all taught disciplines. The book "Aspects of Combinatorics", published by the publishing house of NBU (ISBN 978-619-233-246-4), is written in co-authorship with Professor Ivan Landzhev. The book (textbook) generally reflects the lectures (on combinatorics and finite geometries), read at NBU and SU "St. Kl. Ohridski". Some chapters in it have a monographic character.

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

Associate Professor Asya Ruseva's scientific research are in the field of finite geometries and their connection with the theory of linear codes. Eighteen articles are presented for the competition, in which the following groups of problems are investigated:

1. Extensibility of linear codes and arcs and structure of (t mod q)-arcs

2. Optimal codes and basic problem of coding theory

3. Codes and arcs with a small number of weights

4. Constructions of affine blocking sets

5. Determining the p-rank of incidence matrices of Jelmslev projective planes

The results of problem 1 are published in the articles [2,4,10,12,13,15,16,18] from the presented list of publications. In [18] the statement is proved that if an arc for which there exist only hyperplanes with multiplicities comparable to n, n + 1, . . . , n + t (mod q) and for which the number of hyperplanes satisfies a certain inequality depending on a special constant A, then it is solvable. This result provides an improvement of the Hill-Lizac theorem in this direction. In works [15] and [16] a special geometric object called (t mod q)-arch is introduced for the first time: an arch in PG(r, q) is called a (t mod q)-arch if the multiplicity of each line of PG(r,q) is comparable to t (mod q). If the multiplicity of each point does not exceed t, then such arcs are called strong (t mod q)-arcs. One of the important results in [15,16] is that the dual arch of an arch with quasi-divisibility is a strong (t mod q)-arch. A classification of all strong (3 mod 5)-arcs in PG(3,5) is made. They are lifted with three exceptions – arches with capacities 128, 143 and 168 [4]. In [2], a purely geometric construction of these three arches is made and their uniqueness is proved. In [12] it is shown that the (0 mod p)-arcs, p being a prime number, form a vector space that arises from the complements of the hyperplanes.

The results of problem 2 are published in the articles [5,8,9,14]. The works of this group are devoted to the classic problem of determining the minimum length of a linear code with a fixed dimension k, a fixed minimum distance d over a fixed field Fq. This value is denoted by $n_q(k, d)$. In [14], the growth of the function $t_q(k) := n_q(k, d) – g_q(k, d)$, where $g_q(k, d)$ is the right-hand side of the Griesmer equation, is studied. Several estimates of $t_q(3)$ for different q are obtained: (a) $t_q(3) \leq q/2 - 5$ for q = 2h; (b) $t_q(3) \leq (q - 3)/2$ for q odd power of a prime number; (c) $t_q(3) \leq 2\sqrt{q} - 1$ for q exact square. These estimates are relevant to finding upper bounds on the maximum arc power in the PG(2,q) plane. In [9], a family of parameters related to the parameters of the elliptic quadric in PG(3,q) is studied. There are consider arcs with parameters $(q^3 + 2q^2 + q + 2, q^2 + 2q + 2)$ and their associated $[q^3 + 2q^2 + q + 2, 4q^3 + q^2 - q]$q-codes. In [8], the nonexistence of arches with parameters (395,100), (396,100), (448,113), (449,113) in PG(4,4) is proved. This rejects the existence of Griesmer codes with parameters [395,5,295]4, [396,5,296]4, [448,5,335]4, [449,5,336]4, which solves four of the open cases of the basic problem of coding theory for q = 4, k = 5. Blocking sets with parameters $(v3 + 2v2, v2 + 2v1)$ in PG(3,q) are investigated in connection with the construction of special ternary linear codes [5].

The results of problem 3 are published in the articles [3,6,11]. It is proved that any arc in PG(r, q), $r \geq 3$ for which the multiplicities of the hyperplanes are contained in an interval of length 2 (i.e., these multiplicities are w, w+1 or w+2 and there exist hyperplanes with multiples

w and w + 2), is trivial [11]. Designs are used to construct binary codes with two distances. It is proved that the existence of 2-(v, k, 1) designs yield binary codes with parameters (n = v, M = v(v − 1)/k(k − 1), {2k−2, 2k}). In a number of cases (especially for designs with k = 3 and 4), they give codes with optimal parameters. The main problem addressed in these works is the determination of the exact value of $A_2(n, \{d_1, d_2\})$, defined as the maximum number of words in a binary code of length n and distances between code words d_1 or d_2. The limit $A_2(n, \{2, d\})$ is found for $5 \leq d \leq n - 2$ and for $d = n - 1$. It is proved that for d odd A_2 $(n, \{d, 2d - 2\})$ holds $\leq n + 1$. An example of codes lying on this improved bound is constructed. They are of length $n = q^2 + q + 1$, where q = 2h, and d = q + 1. The general limit $A_2(n, \{d_1, d_2\}) \leq (n+2/2)$ is proved in [6], where there are no restrictions on the parameters of the codes. In [3] designs are used to construct binary codes with two distances. It is proved that the existence of 2-(v, k, 1) designs yield binary codes with parameters (n = v, M = v(v − 1)/k(k − 1), {2k−2, 2k}). In a number of cases (especially for designs with k = 3 and 4), they give codes with optimal parameters.

The results of problem 4 are published in the articles [7,17]. The idea of constructing optimal blocking sets as a union of suitably chosen lines in AG(n, q) is used. The main result is given in Theorem 4 [7]. Using this theorem, a (120,8)-blocking set in AG(9,8) reaching the Bol lower bound is constructed. Similarly, four other optimal blocking sets with parameters (12s + 16, 4)-blocking set in AG(4s + 1, 4) for s = 1, 2, 3,4 are constructed.

The results of problem 5 are published in the article [1]. There are consider the problem of determining the p-rank of the incidence matrix of a Jelmslev projective plane over a chain ring with a residual field of characteristic p. For the incidence matrices of projective geometries PG(r,q), $q = p^h$, the problem is solved independently by different mathematicians, and in the general case – incidence matrix s- of t-subspaces – an exact rank formula is found by Hamada. In the case of geometries over chain rings, a formula analogous to Hamada's formula is not known. Several partial results are demonstrated. The ranks of the incidence matrices of planes over four-element rings are determined (without the aid of a computer) and bounds for planes over 9-element rings are proved, which generalize to bounds for planes over an arbitrary chain ring with nilpotency index 2. The problem is closely related to the characterization of the (0 mod p)-arcs in the planes PHG(2, R), $|R| = q^2$, $q = p^h$.

Associate Professor Asya Ruseva presented a list of 19 citations in journals with IF or SJR.

6. Critical notes and recommendations

I have no critical notes. I believe that the works presented in terms of: motivation; precise and clear presentation of results; literary awareness are at a high level.

7. Personal impressions of the candidate

I have known Associate Professor Ruseva since 2000, when she began to attend and participate in the work of the national coding seminar and a number of other international conferences on algebraic and combinatorial coding theory. She delivered her messages and reports very competently and approachably.

8. Conclusion on the candidacy

After having familiarized myself with the materials and scientific works presented in the competition and based on the analysis of their significance and the scientific and scientific-applied contributions contained in them, **I confirm** that the scientific achievements meet the requirements of the Law on the Development of the Academic Positions of the Republic of Bulgaria, Regulations for the Application of the Law on the Development of the Academic Positions of the Republic of Bulgaria and the Regulations on the Conditions and Procedures for Acquiring Scientific Degrees and Holding Academic Positions at SU "St. Kliment Ohridski" for the candidate to occupy the academic position of "Professor" in the scientific field and professional direction of the competition. In particular, the candidate satisfies the minimum national requirements in the professional direction and plagiarism has not been found in the scientific works submitted for the competition.

I give my **positive assessment** to the candidature.

II. General Conclusion

In view of the above, **I recommend** the scientific jury to propose to the competent authority for the selection of the **Faculty of Mathematics and Informatics at the SU "St. Kliment Ohridski"** to select **Associate Professor D.Sc. Asya Petrova Ruseva-Landzheva**, FMI of SU "St. Kliment Ohridski" to occupy the academic position of **"Professor"** in professional direction **4.5 Mathematics (Finite geometries)**.

Oct 27th, 2023 Prepared the review:

(Prof. Ph.D. Nikola Zyapkov)