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 (Finite Geometries),
announced in SG, issue 67 /04.08.2023
for the needs of Sofia University "St. Kliment Ohridski",
Faculty of Mathematics and Informatics,
Department of Geometry

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-38-576 / 05.10.2023 of the the Rector of Sofia University.

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

Associate Professor Dr. Sci. **Assia Petrova Rousseva-Landjeva**, 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".

The presented documents are:

1. Application by Associate Professor Assia Rousseva for participation in the competition, 26.09.2023.
2. Curriculum vitae in the common European format.
3. Diploma of completed higher education from Sofia University.
4. Diploma for the acquired educational and scientific degree "doctor".
5. Diploma for the acquired scientific degree "doctor of sciences" from Sofia University.
6. Complete list of the scientific publications of the candidate.

7. List of scientific papers for participation in the competition.
8. Copies of the papers for participation in the competition.
9. Signed author's reference for the scientific contributions of the works.
10. List of citations.
11. Information on the fulfillment of the minimum requirements for the academic position "Professor" in professional field 4.5. Mathematics.
12. Copy of the State Gazette with the announcement for the competition.
13. Different declarations needed for the competition.

2. Information for the applicant.

Assia Rousseva graduated in Mathematics from the Sofia University “St. Kliment Ohridski" in 1988. In 2005 she defended her doctoral dissertation on the topic "Arcs in finite projective geometries and their applications in coding theory" under the supervision of Prof. Ivan Landjev. As of 2020, Associate Professor Rousseva is a Doctor of Sciences after defending a dissertation titled "Finite geometries and codes".

From 1993 until now, Assia Rousseva-Landjeva has been a lecturer in the "Geometry" department of FMI, SU "St. Kliment Ohridski", since 2009 she is an associate professor.

Assia Rousseva-Landjeva has a rich scientific activity. She is the author or co-author of over 55 publications in scientific journals and in scientific conference proceedings. She is a coauthor of a textbook in combinatorics. She participated in many conferences in Bulgaria and abroad.

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

Associate Professor Assia Rousseva-Landjeva applies to the competition with 18 publications, all in English. I consider the following classification of her research:

- Four articles were published in *Designs, Codes and Cryptography* in 2014, 2016, 2020 and 2023, respectively. For all four years, the journal has been in the Q2 quartile of WoS. In terms of Scopus, DCC2014 and DCC2016 are in quartile Q2, and DCC2020 and DCC2023 are in quartile Q1. All four articles have an impact factor and SJR, with the most recent article having the highest impact factor of 1.6.
- The papers P3 and P7 are published in journals that also fall into quartile Q2 for both bases indicated. The journals are *Discrete Mathematics* and *Results in Mathematics*. Both papers have an impact factor and SJR.
- The paper P4 was published in the journal *Advances in Mathematics of Communications*, which falls in the Q3 quartile of WoS and the Q2 quartile of Scopus.

- Four papers have been published in journals that fall within the Q4 quartile of WoS, two of which are in *Comptes rendus, de l'Academie Bulgare des Science*.
- Four of the publications are outside the WoS quartiles but fall within the Scopus quartiles, with P13 and P14 being published in the electronic journal *Electronic Notes in Discrete Mathematics*, which falls in Q3, and P1 and P5 being in *Lecture Notes of the ICST* and are in quartile Q4.
- Publications P9 and P18 were published in conference proceedings, and P16 in the yearbook of FMI, SU "St. Kliment Ohridski".
- Only in one of the publications, namely P16, Assia Rousseva is the only author. In all other papers, her co-author is Prof. Ivan Landjev. Articles P11 and P15 are also co-authored by Leo Storme. The paper P2 has two more co-authors, one of whom, namely Sascha Kurz, is also a co-author in P4. The publications P1, P3 and P5 also have one more co-author each, respectively Maryam Bajalan, Konstantin Vorobev and Emilian Rogachev.

Publications P15 and P17 are included in the indicator group B (instead of habilitation work), and they carry 120 points in the table of scientometric indicators (with a required minimum of 100 points). Publications submitted for indicator group D carry 543 points with a required minimum of 200 points. In general, in the table with scientometric indicators, the sum of the points for the documents submitted by the candidate, a total of 952 points, far exceeds the minimum of 550 points required by the Regulations for the Implementation of the Law on the Development of the Academic Staff in the Republic of Bulgaria for professional field 4.5. Mathematics.

A reference is presented for 19 citations with which Assia Rousseva participated in the competition, with 12 of them carrying 8 points each, and the remaining seven carrying 4 points each.

Associate Professor Assia Rousseva has also presented a complete list of 55 publications, of which 29 are in scientific journals, and the rest are in conference proceedings or yearbooks. The results have been reported at over 80 conferences. She was the head of 10 projects financed by the Scientific Research Fund of Sofia University.

Prof. Rousseva-Landjeva's indicators according to Scopus are: h-index 4, 42 citations (without self-citations), 8 co-authors.

All but one publications of Assoc. Prof. Rousseva on the competition are joint works with different researchers. All co-authors have provided declarations of equal contribution. 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

Associate Professor Assia Rousseva-Landjeva has a rich pedagogical biography. Her teaching activity is entirely at SU "St. Kliment Ohridski". She started in 1987 as a demonstrator in the Department of Geometry at the Faculty of Mathematics and Informatics. After graduating in 1988, she was a part-time assistant at the same department. Since 1993 she has been an assistant, since 2001 - senior assistant, since 2003 - chief assistant, and since 2009 she has been an associate professor in the same department. She teaches the following disciplines:

- Geometry - 3rd year, bachelor program "Informatics";
- Geometry - bachelor program "Mathematics and Informatics";
- Analytical geometry - bachelor programs "Informatics" and "Mathematics and Informatics";
- Descriptive geometry – optional discipline for the master's program "Algebra, Geometry, Topology".

In co-authorship with Prof. Ivan Landjev, she publishes the textbook *Aspects of Combinatorics*, which generally reflects the lectures on combinatorics and finite geometries, read at New Bulgarian University and SU "St. Kl Ohridski", with some chapters having a monographic character. The book is written at a high mathematical level, with statements presented and proven in detail, to which interesting examples are attached, and exercises are given at the end of each chapter.

I have no direct impressions of Assoc. Prof. Rousseva's work as a teacher, but I have positive feedback from her students who are satisfied with 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. Assya Rousseva is mainly related to finite geometries and their relationship with linear codes. The publications with which she applied for this competition relate to several more specific topics:

(1) Extendability of linear codes and arcs and structure of (t mod q)-arcs are discussed in [2], [4], [10], [12], [13], [15], [16] and [18]. In the works [15] and [16], a *(t mod q)*-arc was introduced for the first time for an arc in PG(r,q), for which the multiplicity of each line of the given projective geometry is congruent to *t (mod q)*. If in addition the multiplicity of each point does not exceed *t*, we have a strong *(t mod q)*-arc. The description of this type of arc becomes significantly more complicated with the increase of the parameter t and the dimension of the space r. In the paper [16], some (3 mod 5)-arcs with small cardinality are classified. It is also proved that all (2 mod q)-arcs in PG(r,q) for $r \geq 3$ are obtained by a special construction called lifting. In the article [15], using the type of arcs introduced in this way, a theorem was proved, which summarizes earlier results of a number

of specialists in the field. This theorem is among the main scientific results of the candidate, and therefore I state it here.

Theorem. Let K be a Griesmer (n,n-d)-arc in PG(k-1,q) that is t-quasi-divisible modulo q. If $d = sq^{k-1} - \sum_{i=0}^{k-2} \epsilon_i q^i$, $0 \leq \epsilon_i < q$, where $t = \epsilon_0 < \sqrt{q}, \epsilon_1 < \sqrt{q}, \dots, \epsilon_{k-2} < \sqrt{q}$, then K is t-expandable.

Here, a Griesmer (n,n-d)-arc in PG(k-1,q) corresponds to a linear Griesmer [n,k,d]_q code. Any Griesmer code whose minimum weight is divisible by the characteristic of the field is a divisible code, and all its non-zero weights are divisible by the power of this characteristic (we also call them t-divisible codes if t is the greatest common divisor of all the weights in the code). This result can also be reformulated for arcs for which the multiplicities of the hyperplanes are congruent to the power of the arc modulo t. In the case where the minimum weight of a Griesmer code is not divisible by the field characteristic p, it often turns out that non-zero code weights yield identical residues modulo p. This leads to the definition of an arc (and thus a linear code) with quasi-divisibility. In the articles on this topic, in addition to these and some other theoretical results, arcs with specific parameters, such as (3 mod 5)-arcs in PG(3,5) and others, were studied. For some specific parameters, and in some more general cases, arcs are studied for extendability. In [4] a complete classification of (3 mod 5)-arcs in PG (2,5) and PG(3,5) was made, which was used in the proof of the non-existence of (104,22)-arcs in PG(3 ,5) – one of the four open cases for Griesmer codes of dimension 4 over a field with 5 elements.

(2) Optimal codes (papers [5], [8], [9], [14]). Assia Rousseva called this part „Optimal codes and the main problem in Coding theory ". The considered problem is one of the major problems in Coding Theory, and it is the following: Find the minimum length n, for which a linear $[n, k, d]$ code over a field with q elements exist for given values of the dimension k, the minimum distance d and a given finite field $GF(q)$. There are upper bounds for this minimum length, as one of the most important bounds is the Griesmer bound, and the codes, meeting this bound, are called Griesmer codes. In the research of Assia Rousseva this problem is studied from a geometrical point of view. Codes with length close to the Griesmer bound are also interesting and important. Therefore the research on the function $t_q(k)$ is helpful, where

$$t_q(k) = \max_{0 \leq d < \infty} \left(n_q(k,d) - g_q(k,d) \right), \qquad g_q(k,d) = \sum_{i=0}^{k-1} \left\lceil \frac{d}{q^i} \right\rceil.$$

This function sets the deviation of the length of an optimal linear code from the value set by the Griesmer bound $n \geq g_q(k,d)$. This function is studied in [14]. The authors provide general constructions that give upper bounds on this function.

In [9] the authors consider the existence problem for arcs with parameters (q^3+2q^2+q+2, q^2+2q+2) in $PG(3,q)$. Such arcs correspond to Griesmer $[q^3+2q^2+q+2,4,q^2+2q+2]_q$ codes. They are trivially obtained as the sum of a maximal cap in PG(3,q) and the whole geometry. They also prove that for q = 5 and 7 this is the only possible construction. This was known to be the case also for q = 4.

In the publication [8], the authors prove the nonexistence of the hypothetical arcs with parameters (395,100), (396,100), (448,113), (449,113) and $\mathrm{PG}(4,4)$. This result prove the nonexistence of Griesmer codes with parameters [395,5,295], [396,5,296], [448,5,335] and [449,5,336] over a field with 4 elements.

The proof of the non-existence of Griesmer $[104,4,82]_5$ codes from [4] is just one of many examples where extendability results are used. In a series of papers Landjev and Rousseva have introduced the concept of (t mod q)-arcs as a general framework for extendability results for codes and arcs. In this paper they complete the known partial classification of (3 mod 5)-arcs in PG(3,5) and uncover two missing, rather exceptional, examples disproving a conjecture of Landjev and Rousseva.

In [2], the authors give a geometric construction of the three strong non-lifted (3 mod 5)-arcs in PG(3,5) of respective sizes 128, 143, and 168, and construct an infinite family of non-lifted, strong (t mod q)-arcs in PG(r,q) with $t=\frac{q+1}{2}$ for all $r \geq 3$ and all odd prime powers q.

(3) Codes and arcs with small number of nonzero weights (papers [3], [6] and [11]). Any linear constant-weight code is a concatenation of simplex codes. One can expect a similar result for linear codes with small number of nonzero weights. The codes and corresponding arcs with this property are called codes, resp. arcs, with almost constant weight. The authors consider the problem of determining the exact value of $A_2(n,\{d_1,d_2\})$, defined as the maximal cardinality of a binary code of length n with two possible distances d_1 and d_2. They prove that if $d_2 > 2d_1$, one has $A_2(n,\{d_1,d_2\}) \leq n+1$. A similar bound holds for codes with $d_1 \not\equiv d_2 \ (mod\ 2)$ is:

$$A_2(n,\{d_1,d_2\}) \leq \begin{cases} n+1 & \text{for } d_1 \text{ even,} \\ n+2 & \text{for } d_1 \text{ odd.} \end{cases}$$

Finally, the general upper bound $A_2(n,\{d_1,d_2\}) \leq \binom{n+2}{2}$ was proved.

(4) Constructions of affine blocking sets (papers [7] and [17]). A t-fold affine blocking set is a set of points in $\mathrm{AG}(n,q)$ intersecting each hyperplane in at least *t* points. To obtain good results, the idea of constructing optimal blocking sets as a union of appropriately chosen lines in the considered affine geometry was used. The existence of (N,t)-blocking set in $\mathrm{AG}(n,q)$ is equivalent to the existence of a linear $[q^n-N, n+1, q^n-q^{n-1}-N+t]_q$ code containing a codeword with maximum weight q^n-N.

(5) Determining the p-rank of the point-by-line incidence matrix of the projective Hjelmslev plane over the chain rings with 4 and 9 elements. The proof uses a characterization of all divisible arcs in the corresponding projective planes. Furthermore, the authors prove lower and upper bounds on the p-rank of the incidence matrix of the projective Hjelmslev plane over an arbitrary finite chain ring of nilpotency index 2.

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 Assia Rousseva for many years. I have listened to all of her presentations at the ACCT (Algebraic and Combinatorial Coding Theory) and OCRT (Optimal Codes and Related Topics) conference series, as well as the annual coding theory seminars. She is a very good lecturer, her talks are precisely prepared and convincingly presented. Prof. Rousseva is a leading specialist at international level in the field of finite geometries.

Assia Rousseva is a very sociable and responsive person. I have excellent impressions from our meetings at various conferences and seminars.

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. Assia Petrova Rousseva-Landjeva** 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. Kliment 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. Kliment Ohridski" to elect **Assoc. Prof. Assia Petrova Rousseva-Landjeva** to occupy the academic position "Professor" in the professional field 4.5 Mathematics (Finite Geometry).

16 November 2023 Reviewer: .....

(Prof. Stefka Bouyuklieva)