REFEREE REPORT

by professor PhD Nikolai Manev,

The Institute of Mathematics and Informatics – BAS

on the dissertation thesis of **Assia Petrova Rousseva** entitle

“Finite Geometries and Codes”

submitted for acquiring the scientific degree “**Doctor of Sciences**”
Area of Higher Education: **4. Natural Sciences, Mathematics and Informatics**,
Professional Field: **4.5 Mathematics**

1. General description of the procedure and submitted documents

To be a member of the Scientific Jury I am appointed by the Rector of the Sofia University “St. Kliment Ohridski” with Order № RD 38-136 / 14.05.2020.
In such a capacity I received the following documents (in digital form) that concern the procedure.

1. The thesis “Finite Geometries and Codes” by Assia Rousseva
2. Abstract of the thesis (in Bulgarian and English)
3. Signed by Assia Rousseva information that she meets the requirements of the Act on Development of the Academic Staff in the Republic of Bulgaria
4. Lists of citations of her works (as a part of document 3)
5. Ph.D. degree diploma No 30097 issued on 27.12.2005
6. CV

Document 3 is correct and shows that the applicant fully meets the national requirements as well as the Regulations for the conditions and rules for acquiring scientific degree of the Sofia University “St. Kliment Ohridski”.

2. Biographical data about the applicant

Assia Rousseva received MS degree in 1988 at the Faculty of Mathematics and Informatics of the Sofia University “St. Kliment Ohridski”. She starts her academic career in January 2001 as assistant professor. Since 2009 she has been associate professor at the Faculty of Mathematics and Informatics of the Sofia University “St. Kliment Ohridski”, Department of Geometry and Topology. The Ph.D. degree was conferred on her in 2005 after the defense of the thesis “Geometries over finite fields, coding theory, combinatorial configurations”.

3. Approbation of the results in the dissertation

The results presented in the dissertation have been published in 7 papers. In two of them Assia Rousseva is the sole author, in the others 5 she has one coauthor. Three papers have impact factor and the applicant is the only author in one of them. The rest are published in indexed journals without impact factor or rank (two of these journal recently have impact factor).

The papers have not been used for acquiring PhD degree and for occupying her recent position of associate professor.

4. Assessment of the personal contribution of the applicant in joint works

In my opinion the personal contributions of Assia Rousseva to joint papers are equipollent.

5. Impact of the results on the work of other scientists

Assia Rousseva has attached a list of 13 citations of her papers. 12 of them are in journals with impact factor.

My conclusion is that Assia Rousseva is well known to the researchers working in her scientific area.

6. Quality of the dissertation Abstract

The Abstract contains 28 pages and presents correctly the content of the chapters and the spirit of the dissertation as a whole. At the end of the Abstract is given a summary of the main results obtained in the dissertation.

7. Description and analysis of results in the thesis

The dissertation thesis contains 180 pages and consists of five chapters and References with 201 titles. The first chapter is entitled “Introduction” and presents the motivations for the study as well as the main results. Chapter 2 contains the notions and facts necessary for reading and understanding the rest of the thesis. The author’s results are given in Chapters 3, 4, and 5.

The presentation is succinct but very readable.

In the first chapter after shorts historical notes about development of Finite Geometry and Coding Theories the author gives a review of each chapter of the thesis section by section. She underlines the main problems and results in each section.

In Chapter 2 the deep interconnection between finite geometries and codes is presented and discussed.

Chapter 3 entitled “Arcs and optimal codes” is the best demonstration (in the thesis) of the aforesaid interconnection. It is investigated the behavior of function $t_q(k)$ defined as the maximal deviation of the optimal length of a code of dimension k from the value given by the Griesmer bound.

The main result in Section 3.2 is Theorem 3.10, which can be viewed as a generalization for non-Griesmer codes of the construction by Belov, Logachev, and Sandimirov. Based on this construction upper bounds for $t_q(k)$ are obtained for even k.

In section 3.3 the problem of the rate of growth of $t_q(3)$ is investigated. S. Ball made the conjecture $t_q(3) \leq \log q$. In the thesis it is proved that for $q=2^h$ the inequality $t_q(3) \leq \log(q) - 1$ holds, while $t_q(3) \leq \sqrt{q} - 1$ when q is an even power of prime.

In the last sections of Chapter 3 Assia Rousseva presents her results on characterization and nonexistence of arcs with given parameters. The obtained facts result in improving the known bounds for minimum possible block length $n_4(5,d)$.

Chapter 4 entitled "**Extendability of arcs and codes**" discusses the extendability problem for linear codes but in geometrical language, as problem of extending arcs in projective geometries. Under what conditions an (n,w)-arc in $PG(r,q)$ is extendable to an $(n+1,w)$-arc by increasing multiplicity of a point? The idea introduced by the author is to relate the extendability of a given arc K with the structure of a special arc K' in the dual geometry.

The notion arc with t-quasidivisibility is introduced in this chapter. Such arcs are rather common when Griesmer codes with $d \equiv -t \pmod q$, $t < q$ are studied. A special class of arcs called $(t \bmod q)$-arcs are introduced, too. They are dual to arcs with the property t-quasidivisibility.

The main result in Section 4.1 is Theorem 4.3 that gives the interconnection between extendability of t-quasidivisibility arc and structure of the corresponding ($t \bmod q$)-arc. This fact argues the studies structure of $(t \bmod q)$-arcs in the next section.

Section 4.3 is devoted to $(t \bmod q)$-arcs with property that maximum multiplicity of a point is t. The obtained results imply nonexistence of codes with given parameters.

The last two sections of the Chapter 4 present results about extendability of Griesmer arcs. The most important results are given by Theorems 4.26 and 4.27. In particular the obtained results close an open case for codes with $k=4$, $q=5$.

Chapter 5 presents investigations concerning blocking sets in affine geometry $AG(n,q)$. The main result is given in Section 5.2. It is a new general construction of affine blocking sets. For a given parameters this construction gives an infinite class of affine blocking sets meeting the Bruen bound as well as new examples of optimal blocking sets that have the minimal cardinality for fixed

t, n and *q*. Furthermore, by this construction five optimal blocking sets are constructed. They are the first examples meeting the bounds of Ball and Ball-Blokhuis.

The main contributions of Assia Rousseva are correctly listed on pages 23 and 24 in the Abstract. They are significant contributions to solving difficult and interesting problem in two mathematical areas.

CONCLUSION

The dissertation thesis of Assia Rousseva contains theoretical results that are original and significant contribution to Finite Geometry and Coding Theory. The thesis fully meets the requirements of the Act on Development of the Academic Staff in the Republic of Bulgaria, the Regulations for its application, and the Regulations for the conditions and rules for acquiring scientific degree of the Sofia University "St. Kliment Ohridski"

Based on the aforesaid in this report **I give positive estimation of the considered dissertation and strongly recommend the Scientific Jury to confer on Assia Rousseva the scientific degree "Doctor of Science" in 4. Natural Sciences, Mathematics and Informatics**, **professional field: 4.5 Mathematics, scientific specialty: Geometry an Topology**

8.07.2020 г. Signature:

Sofia Prof. PhD N. Manev