O P I N I O N

For the competition for the Academic position
Professor, In the area of Higher Education
4. Natural Sciences, Mathematics, and Informatics,
Professional Direction 4.5. Mathematics,
Scientific Specialty Algebra (Semigroups of Transformations),
Published in the Bulgarian State Newspaper no. 84/21.10.2022

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March 21, 2023

This opinion was prepared by: Professor, PhD, Plamen Emilov Koshlukov, from the Department of Mathematics, State University of Campinas, Brazil, as a member of the Scientific Jury for the Competition in Professional Direction 4.5. Mathematics, Scientific Specialty Algebra (Semigroups of Transformations), in accordance with the Order no. 536/20.12.2022 of the Director of IMI, BAS.

The only candidate to apply for the position is Associate Professor PhD Jorg Koppitz, for the Section of Algebra and Logic at the Institute of Mathematics and Informatics at the Bulgarian Academy of Sciences.

1 General description of the submitted materials

1.1 Information about the candidate

The documents submitted by the candidate Assoc. Prof. PhD Jorg Koppitz satisfy the requirements imposed by the Bulgarian Law and also the Regiment of the Bulgarian Academy of Sciences concerning the procedures for promotions and assumption of Academic position at the Academy.

The candidate Assoc. Prof. PhD Jorg Koppitz submitted for this competition a list of 17 (seventeen) titles, all of them publications in international refereed scientific journals. He also submitted 18 (eighteen) other documents (such as employer's statements, declarations, lists of research projects, editorial activities, conference talks, organization and participation of conferences and workshops, diplomas, prizes, and other suitable proofs), in support of his application.

Assoc. Prof. PhD Jorg Koppitz obtained his PhD degree from the Martin Luther University, in Germany, on December 20, 1993. On April 18, 2002, he obtained his Habilitation Doctoral Diploma, Natural Sciences Doctor, Algebra, by means of the hablilitation thesis "M-solid varieties of semigroups". Assoc. Prof. PhD Jorg Koppitz was elected an Associate Professor at the BAS on May 05, 2017, in the direction of Algebra and Number Theory (Algebraic Structures). He is the author of a monograph, and 96 papers published in international refereed specialized joiurnals. He is member of the Editorial Board of two international journals. He also supervised 9 (nine) PhD students. He took part in the Organizing Committees of 5 (five) international conferences, and in the Program Committes of two conferences. He also visited more than 50

Universities where he delivered talks representing his results. Assoc. Prof. PhD Jorg Koppitz has a good network of collaborators in several Universities abroad.

The submitted documents describe in detail Assoc. Prof. PhD Jorg Koppitz' research and teaching activities. These documents represent a strong evidence that Assoc. Prof. PhD Jorg Koppitz has developed rich and ample scientific and teaching activities, and has obtained significant mathematical results.

1.2 Candidate's Bio

The candidate Assoc. Prof. PhD Jorg Koppitzwas born on September 07, 1966, in Germany. He obtained his PhD degree in 1993, from the Martin Luther University, and his Habilitation Diploma in 2002, from the University of Potsdam. He worked for the University of Potsdam from 1992 to 2015, and in 2017 he became a Research Associate at the Institute of Mathematics and Informatics at the Bulgarian Academy of Sciences. In 2017 he was elected an Associate Professor at the IMI–BAS. He is fluent in German, English, Bulgarian and Russian languages. Assoc. Prof. PhD Jorg Koppitz works at the Section of Algebra and Logic, IMI–BAS. His research interests are in the area of Semigroups and applications, an area where he is a recognized specialist.

1.3 Outline of the Candidate's scientific results and achievements

Assoc. Prof. PhD Jorg Koppitz is the author of more than 97 (ninety-seven) research papers, published in international refereed journals as well as a monograph. He is a recognized specialist and expert in the Theory of Semigroups. Assoc. Prof. PhD Jorg Koppitz' research interests lie in the areas of Transformation Semigroups, Doppelsemigroups, Semihipergroups, and Semigroups in Universal Algebra. I would like to stress here that the canddiate published papers in Semigroup Forum (9), Journal of Algebra and Applications (4), International Journal of Algebra and Computation (3), Algebra Universalis (3), Communications in Algebra (2), Algebra Colloquium (2), Archivum Matematicum (2), Demonstratio Mathematica, Forum Matematicum, Fixed Point Theory and Applications, and also the monograph, "M-solid varieties of algebras", 341 pp., published by Springer Verlag, in the Series Advances in Mathematics (Springer), co-authored by Klaus Denecke.

All these facts lead to the firm conclusion that:

1. The quantity and the quality of Assoc. Prof. PhD Jorg Koppitz' publications satisfy the requirements imposed by the Bulgarian Law, and respectively by the additional requirements of the Bulgarian Academy of Sciences, for assumption of the academic position of Professor in the Scientific Area of Natural Sciences, Mathematics and Informatics, and Professional Direction of the competition, 4.5. Mathematics, scientific speciality Algebra.

2. The scientific works (published papers) presented by the candidate Assoc. Prof. PhD Jorg Koppitz do not repeat those submitted for previous competitions for promotions.

3. There is no lawful proof of plagiarism in the scientific papers submitted for the competition. It is worth noting that these are published papers in refereed journals in Bulgaria and abroad, and that all of them are available to the Mathematical Community worldwide. Hence one can hardly speak of or consider plagiarism or "stealing" anybody else's results.

4. A declaration is submitted that Assoc. Prof. PhD Jorg Koppitz' contributions and those of his co-authors are equal in the published papers.

1.4 Characterization and evaluation of the Candidate's teaching activities

The candidate Assoc. Prof. PhD Jorg Koppitz taught at various Universities in Germany. He submitted proofs for the courses he had taught at the University of Potsdam, from 1995 to 2017, from 2017 to 2022, as well as for the courses and lectures given at the Universities in Brno, Szeged, Blagoevgrad, Lisbon, Luhansk. I could not find information concerning courses taught at the IMI–BAS, or at the University of Sofia.

1.5 Qualitative analysis of the Candidate's scientific and applied achievements, contained in the materials for the present competition

The scientific contribution of Assoc. Prof. PhD Jorg Koppitz are of theoretical nature. He obtained new results in the theory of semigroups and their applications. As commented above, Assoc. Prof. PhD Jorg Koppitz' contributions can be separated (roughly) in four main directions.

1. Transformation Semigroups. The candidate included here 8 of the 17 papers submitted for the competition. The transformation semigroups are functions of a set into itself, closed under the usual composition of functions. The transformation semigroups satisfying some given, natural properties, have been object of study in very many papers by various authors. A natural and important problem consists in studying such semigroups when the underlying set is considered with some fixed linear order. A far-reaching generalization is obtained when one consider a partial order instead of a linear one. Of particular interest among the partial orders are the so-called zig-zag orders. These orders have been in the mainstream of the theory for the last three decades.

The candidate Assoc. Prof. PhD Jorg Koppitz computed the rank of such semigroups, that is the least number of generating elements, in the case of injective transformations, as well as in the case of complete transformations. He also computed the rank of the transformation semigroups when one considers partial automorphisms, and described the corresponding Green relations. When the transformations act on a finite set with n elements, and the partial order is of the zig-zag type, Assoc. Prof. PhD Jorg Koppitz studied the partial automorphisms. He proved that the monoid of these transformations is generated by transformations of rank at least $n-3$; moreover this turns out to be false if the rank is $> n-3$. The candidate proved that there is no minimal generating set of n is odd. When n is even, such minimal generating sets were described by the candidate. He also obtained results in the cases of infinite sets, as well as in the case of complete transformations.

The study of semigroups having a limited set of images started some 50 years ago. An important characterization of such semigroups is their relative rank, modulo some important subsemigroup. The candidate Assoc. Prof. PhD Jorg Koppitz gave the complete answer to a series of questions concerning the generating elements and the relative rank.

The theory of semigroups has important and direct applications to the Algebraic Graph Theory. Let P_n be a undirected path of length n, its endomorphisms determine a monoid. In the paper [4], the candidate computes the rank, the cardinality, and the Green relations of the monoid of injective partial endomorphisms, as well as of the monoid of partial automorphisms of P_n. The candidate's results in this direction are algebraic. He also gave a description of the regular monoids of both types considered above.

2. The notion of a Doppelsemigroup generalizes that of a semigroup, and is closely related to the notions of doppelalgebras and inter-associative semigroups. The candidate Assoc. Prof. PhD Jorg Koppitz studied the so-called rectangular doppelsemigroupsAmong his most significant contributions in this direction we cite the paper [8]. In it the candidate constructed the free objects, computed their cardinality, and gave a concrete description of the corresponding groups of automorphisms. In the paper [10] the candidate proved an analogous result to the well known theorem of Cayley for groups, in the case of doppelsemigroups and doppelmonoids. In the paper [11] he studied the construction of free product in the class of n-ary semigroups satisfying some additional properties. He also constructed the free commutative n-ary semigroup and computed its group of automorphisms.

3. Semigroups in Universal Algebra are the main topic of study in 5 of the submitted papers. The candidate studied certain subsets of the symmetric semigroup $T(X, Y)$ and certain nondeterministic transformations. Let $T_P(X, Y)$ be the semigroup of the nonempty subsets of $T(X, Y)$, and let Y be a two-element set. Then the semigroup of the nondetermined Boolean operations can be embedded into $T_P(X, Y)$. In the paper [13] the candidate studied the Green relations and determined the largest congruence contained in a given Green relation. In this way he described the congruence structure of that semigroup. In the paper [6] he studied the ideals in $T_P(X, Y)$ and described the corresponding algebraic structure. He also described the idempotent and the maximal idempotent subsemigroups, as well as the regular elements.

The paper [5] studies hypersubstitutions in algebraic systems, and also describes the idempotents and the regular elements in the monoid of generalized hypersubstitutions in algebraic systems. The paper [17] represents a contribution to the theory of Algebraic systems. The candidate studies in [17] the so-called terms (that is trees whose knots are operations and whose branches are either variables or null operations). In this way the candidate studies varieties of groupoids and their stability. He described all 10 stable varieties of semigroups, these are at the base of the lattice of all varieties of semigroups. He found also interesting examples of stable varieties.

4. Semihypergroups were studied in the paper [12]. The main contribution of that paper is the theorem that every semihypergroup can be considered, in a sense, as a semigroup. This allowed the candidate to describe all semihypergroups of order 2, there exist exactly 17 of these.

According to the candidate, his papers have been cited in total by 102 papers (excluding self-citations). The papers submitted for this position have been cited 26 times (once again excluding self-citations). Lists of these citations are submitted as well.

The papers submitted for the present competition were published in international refereed journals, and the sum of the impact factors of the papers is 9.755. Out of the 17 papers, 10 are with one co-author, 5 are with two co-authors, and 2 with three co-authors. A documents stating that the contributions of the authors are equal, is submitted as well.

1.6   Critique and Recommendations

I have nothing to comment here.

1.7   Personal Impressions of the Candidate

I do know Assoc. Prof. PhD Jorg Koppitz, I met him on several occasions at the IMI–BAS. On the other hand I cannot give more concrete information about his personality because of the brevity of these meetings.

1.8   Conclusion about the Candidate

Having read the documents submitted by Assoc. Prof. PhD Jorg Koppitz for the competition, and based on the analysis of their importance and the research advancements of the candidate, I confirm that the scientific achievements of scientific satisfy the requirements of the Bulgarian Law, as well as the Regiments of the Bulgarian Academy of Sciences, for promotion to the academic position of a Professor in the Scientific Area of Natural Sciences, Mathematics and Informatics, and Professional Direction of the competition, 4.5. Mathematics, scientific speciality Algebra. I have no doubt that the candidate Assoc. Prof. PhD Jorg Koppitz satisfies with ease the minimal requirements in the Professional Direction, and there is no known plagiarism concerning the scientific works submitted for this competition. Thus I am favourable of the approval of the candidate Assoc. Prof. PhD Jorg Koppitz.

2   General Conclusion

Taking into consideration the above exposition, I recommend to the Scientific Jury to submit to the competent body for the election in the Institute of Mathematics and Informatics at the Bulgarian Academy of Sciences, to elect Assoc. Prof. PhD Jorg Koppitz to assume the academic position of Professor in Professional Direction of the competition, 4.5. Mathematics, scientific speciality Algebra (Transformation semigroups).

Campinas, March 17, 2023

Signed:

Professor Dr. Plamen Emilov Koshlukov