REVIEW

in a competition for an academic position

" Associate Professor "

in a professional direction 4.5. "Mathematics (Mathematical modeling and application of mathematics and mechanics in robotics)",

for the needs of Sofia University "St. Kliment Ohridski ”(SU),

Faculty of Mathematics and Informatics (FMI),

Announced in SG no. 21 of 15.03.2022 and on the websites of FMI and Sofia University

The review was prepared by: Prof. Dr. George Vencislavov Boiadjiev - FMI, Sofia University, 4.5. Mathematics, "Mathematics, theoretical mechanics and robotics", in my capacity as a member of the scientific jury of the competition according to Order № RD-38-234 / 11.05.2022 of the Rector of Sofia University

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

Ch. Assistant Professor Dr. Alexander Alexiev Stefanov

Faculty of Mathematics and Informatics, Sofia University “St. Kliment Ohridski ”

I. General description of the presented materials.

1. Details of the application.

The documents submitted by the competition by the candidate comply with the requirements of ZRASRB, PPZRASRB and the Regulations on the terms and conditions for acquiring scientific degrees and holding academic positions at Sofia University "St. Kliment Ohridski ” (PURPNSZADSU).

For participation in the competition the candidate **Ch. Assistant Professor Dr. Alexander Alexiev Stefanov** presented a list of a total of 15 titles (after his procedure for chief assistant in 1917, i.e. the scientific papers submitted by the candidate do not repeat those of previous procedures for acquiring a scientific title and academic position), which are all publications in Bulgarian and foreign scientific journals and scientific forums.

Six of the presented publications are separated as habilitation work according to criteria B4 of PPZRAS.

2. Details of the candidate.

The candidate receives a bachelor's degree in Engineering Physics at Sofia University "St. Kliment Ohridski”, Faculty of Physics, in July 2010. In the period from October 2010 to October

2011, completing the master's program "Theoretical and Mathematical Physics", he obtained the qualification "Master", again at Sofia University "St. Kliment Ohridski", Faculty of Physics. From January 2012 to March 2016 he is a full-time doctoral student also at Sofia University "St. Kliment Ohridski", Faculty of Physics, receiving a doctorate with a degree in "Theoretical and Mathematical Physics". In the period from 25.06.2015 to 07.07.2017 he worked as an assistant at Sofia University "St. Kliment Ohridski", Faculty of Mathematics and Informatics, Department of Mechatronics, Robotics and Mechanics and from 07.07.2017 to the present holds the position of "chief assistant" again in the same department. In addition, the candidate has been working as a part-time assistant at the Bulgarian Academy of Sciences, Institute of Mathematics and Informatics, since 15.04.2015.

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

In the publications submitted for participation in the competition, the candidate is the first author in 3 of them, in 6 he is second, and in the others he ranks third or later. According to the regulations for application of the law for the development of the academic staff in the Republic of Bulgaria the total number of points that the publications submitted for the competition have are as follows: one publication with quartile Q1 (25 points); four publications with quartile Q2 (4 x 20 points); one publication with quartile Q3 (15 points); one publication with quartile Q4 (12 points); three publications with SJR without quartiles - (3 x 10 points). Taking into account the coefficient for increase of points related to professional field 4.5 "Mathematics", the total number of points becomes 162, which is quite sufficient to meet the criterion of the regulations on publications under indicator G7: "Scientific publication in publications that are referenced and indexed in world-renowned databases of scientific information (Web of Science and Scopus) outside of habilitation work".

There is no evidence of individual contribution to the collective work, so the reviewer assumes that the contributions are equal, although the works where the candidate is the first author suggest his leading participation.

There is no legally proven plagiarism in the scientific papers submitted at the competition.

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

The candidate has extensive teaching experience. He has lectured and led exercises in FMI, FzF and BF at Sofia University in the educational qualification degrees Bachelor and Master (compulsory, elective and optional courses, full-time and part-time training) in analytical mechanics, applied mathematics (2 and 3), mathematics and informatics, dynamics, including lectures and exercises on MAFMP in English for foreign students majoring in JATE, FzF, etc.

The lectures and exercises prepared by him are clear and logical, which helps to better understand the material taught. His classroom employment in all school years, during which he has

been teaching so far, always exceeds - and to a large extent, the established norms for workload, which is evident from the submitted and approved personal reports for the respective semesters.

Mention should also be made of the candidate's participation in the organization and holding of the 5th and 6th Olympiad in Experimental Physics, organized by the Sofia branch of the Union of Physicists in Bulgaria.

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

The candidate's scientific contributions can generally be grouped into the following topics: integrable models, robotics, electronics and measurement physics, optics and quantum information. The analysis of the relevant scientific works below follows their numbering as presented by the candidate. The curious thing about this numbering is the addressing of a given publication simultaneously to the criteria for the fulfillment of the minimum national requirements by the RASRB in terms of indicators, and to the place of publication - in the sense of whether it is a journal or conference proceedings. So, for example, "B4-J.xx" means a publication by indicator "B4", published in a journal, with serial number "xx" from the list of presented articles published in journals, or "Г7-С.xx" - a publication by indicator "Г7 ", published in conference proceedings, serial number "xx".

5.1. *Integrable models.*

Publications [B4-J.1, B4-J.2, B4-C.3, B4-C.4, D7-J.6, D7-J.7, D7-C.3] refer to this topic. Multicomponent integrable generalizations of classical nonlinear equations of mathematical physics such as the Korteweg-de Vries equation and the nonlinear Schrödinger equation based on Lax pairs associated with Lie algebras are derived and investigated. The approach is the construction of Katz-Moody algebras (formal series on a given parameter - a spectral parameter, with coefficients in a given simple Lie algebra). It is shown that one way to explicitly construct these algebras is by Coxtere automorphism. The derivation of the hierarchies of integrable equations related to the algebra D_4 (the only one among the simple Lie algebras possessing a third-order external automorphism), as well as the study of the spectral properties of the corresponding Lax operators, the correct formulation of the inverse scattering problem, and the reduction of the recursion operators, was done in paper [B4-J.1]. Further, the hierarchies associated with the series of Ar(1) algebras are also derived and investigated. This is again done with the help of recursion operators, and the spectral properties of the Lax operators, as well as the scattering problem are also considered in [D7-J.6].

Another approach to constructing non-integrable Schrödinger-type equations is by restricting the coefficients of the Lax operators on symmetric spaces, which is done in the papers [B4-J.2, B4-C.3, B4-C.4]. The inverse scattering problem is correctly formulated and it is shown that it can be reduced to a Riemann-Hilbert problem.

The resulting models are generalizations of the Manakov model, the Heisenberg ferromagnet, and the Gerdzhikov-Ivanov equation.

5.2. *Robotics.*

Publications [B4-C.1, B4-C.2] refer to this topic. A major contribution here is the study of a walking robot with two degrees of freedom. A basic dynamic model was developed, with the help of which a control algorithm was proposed, minimizing the motor loads during walking. The model was further extended to include dissipative forces.

An experiment was carried out with the help of a 3D printed prototype, with the predictions of the model matching the experimentally obtained results with an accuracy of 7%. The robot finds application in the educational process and in working with disabled children.

5.3. *Electronics and measurement physics*.

Publications [D7-J.3, D7-J.4, D7-J.5, D7-C.2] refer to this topic. They are devoted to the measurement of fundamental constants in a way accessible to students and pupils, which shows their application in the educational process. Setups have been developed to measure the Boltzmann constant and the charge of the electron, while keeping the setup cost as low as possible. Standard electronic components and integrated circuits are used - operational amplifiers, capacitors, resistors, and measuring equipment is also available - for example, a multimeter. The measurement of the Boltzmann constant is based on the theorem of the equal distribution of energy over the degrees of freedom of the system, while the measurement of the electron charge is based on Schottky noise.

The productions created in this way were used at the Olympiads in experimental physics EPO5 and EPO6. For the modeling of operational amplifiers, an ordinary differential equation modeling the dynamic behavior of the amplifier is derived.

Such an explicit model is missing in the literature (it is known in an implicit form). This model was used to address three important problems: the dynamic behavior and stability of an op-amp in negative impedance converter mode; the frequency dependence of the gain of a non-inverting amplifier; setup to determine transition frequency.

5.4. *Optics*.

Publications [D7-J.1, D7-J.2] refer to this topic. They are based on a method for generating diffraction-free Gauss-Bessel laser radiation by annihilating optical vortices. For this purpose, a theoretical model predicting this phenomenon was developed. A number of experiments have also been carried out, and the results have been published in journals with excellent scientometric performance.

5.5. *Quantum information*.

Publication [G7-C.1] refers to this topic. The simplest example of significance in quantum information is a system of two quantum bits, which is the simplest system exhibiting the phenomenon of entanglement. Its state space is modeled with the SU(4) group. A Cartan expansion

for SU(4) is given, which is analogous to the Cartan expansion in Euler angles for the group SO(3), describing the rotation of the three-dimensional space about a fixed point.

A formula for the von Neumann entropy, which is a measure of the entanglement of the system, is also derived.

The reflection of the candidate's results in the works of other authors is evidenced by the presented 11 citations, of which 7 are in refereed and indexed journals in Scopus/WoS. In this regard, according to indicator D11 of the Regulations for the implementation of the law on the development of the academic staff in the Republic of Bulgaria and taking into account coefficient 4 for PN 4.5 Mathematics, the candidate receives 56 points.

Summarizing the candidate's results and achievements in numerical terms according to the aforementioned regulation, they are as follows: group of indicators B – 168 points (more than the required 100); group of indicators D – 387 points (more than the required 200); group of indicators D – 56 points (more than the required 50).

Along with indicator A - Dissertation work for awarding the educational and scientific degree "doctor", where the candidate's doctoral diploma gives him 50 points, it is clear that his achievements meet the minimum national requirements (according to art. 2b, para. 2 and 3 of ZRASRB) and accordingly to the additional requirements of SU "St. Kliment Ohridski" for occupying the academic position of "associate professor" in the scientific field and the professional direction of the competition and that the necessary criteria for this have been met.

6. Critical remarks and recommendations.

I have no critical remarks regarding the peer-reviewed works of the candidate. In them the statement of the task is clearly formulated, the results are summarized as a result of in-depth analysis, proving their completeness.

The exposition is convincing, which shows the good methodological level of the respective publication, and last but not least the quality and completeness of the cited literature, which testifies to the literary awareness of the author.

Further evidence of the lack of critical notes on peer-reviewed papers is the fact that almost all of them have been published in peer-reviewed and indexed international journals and conferences, including impact factor or SJR.

As a recommendation to the candidate, it would be good to emphasize in his publications the practical application of the obtained result, where possible. For example, as is done in deriving the dynamic equations of motion of a walking robot with two degrees of freedom in the article [B4-C.1].

7. Personal impressions of the candidate.

I have known the candidate since 2015 when he appeared as a candidate for an assistantship in the Department of Mechatronics, Robotics and Mechanics i.e. over 7 years. Since then we have had an excellent relationship both professionally and personally.

In his professional activity, the candidate shows high responsibility, competence based on deep mathematical knowledge, as well as those in the field of robotics and programming.

He has all the necessary qualities and pedagogical skills of an excellent teacher. He works very well in a team (I mean the composition of the department of which he is a member). On a personal level, I will emphasize only some of my impressions - he is always serious in necessary situations; a friend and colleague who can always be counted on; possesses the necessary human virtues in the broadest sense.

8. Conclusion on the application.

After getting acquainted with the materials and scientific works presented in the competition and on the basis of 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 ZRASRB, the Regulations for its application and the respective Regulations of Sofia University "St. Kliment Ohridski "for holding the candidate for the academic position" Associate Professor "in the scientific field and professional direction of the competition.

In particular, the candidate satisfies the minimum national requirements in the professional field and no plagiarism has been established in the scientific papers submitted at the competition.

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

II. OVERALL CONCLUSION.

Based on the above, **I recommend** the scientific jury to propose to the competent authority for the selection of the Faculty of Mathematics and Informatics at Sofia University "St. Kliment Ohridski" to elect Ch. Assistant Professor Alexander Alexiev Stefanov to take the academic position of "Associate Professor" in the professional field 4.5. Mathematics (Mathematical modeling and application of mathematics and mechanics in robotics).

01.07. 2022 Prepared by the review: Prof. Dr. George Boiadjiev

(academic position, scientific degree, name, surname)