

R E F E R E E R E P O R T

by

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Member of the Jury for the selection of the academic position "Professor"

Appointed by the Director of IICT-BAS (No. 166/13.07.2021)

<u>Announcement:</u>	<i>State Gazette, Issue. 45/28.05.2021</i>
<u>Higher education area:</u>	<i>4. Natural sciences, mathematics and informatics</i>
<u>Professional area:</u>	<i>4.5 Mathematics</i>
<u>Scientific specialty:</u>	<i>Numerical Mathematics (High-performance methods and algorithms)</i>
<u>Applicants:</u>	<i>Dr. Ivan Dimov Lirkov, Assoc. Prof. (sole candidate)</i>

1. Brief biographical information

Ivan Lirkov graduated from the Faculty of Mathematics and Informatics (FMI) at Sofia University "St. Kl. Ohridski" in 1988. Acquired qualification: "Master of Mathematics". In the period 1991-1994 he was a graduate student (doctoral student) at the Coordination Center for Informatics and Computer Science (CCIIT) and in 1994 he obtained the scientific and educational degree "Doctor". He speaks excellent Russian and English. Since 1982 he has been working as a teacher at the High School of Natural Sciences and Mathematics "Acad. Nikola Obreshkov Burgas (1988 - 1991); mathematician at IICT (1987-1988 and 1994-1996); research associate III - I grade (1996 - 2002). During this period, he was a leader and participant in many national and international research projects and a member of the organizing and scientific committees of prestigious international conferences.

2. General description of the materials presented

The materials presented to me by Dr. Ivan Lirkov in the announced competition include: (a) CV; (b) diploma of the Doctoral Degree; (c) certificate of Senior degree in science; (d) certificate of occupied academic position at IICT-BAS and an internship in the specialty; (e) list of the scientific

publications submitted for the competition; (f) copies of the scientific publications submitted for participation in the competition; (g) list of selected indexed citations; (h) copyright certificate; (i) brief summaries in Bulgarian and English of the scientific publications submitted for participation in the competition; (j) statement of eligibility for the academic position of professor and (k) declaration of non-existence of plagiarism. All the materials provided to me have been carefully prepared and I have no doubt about their veracity.

3. Reflection of the Candidate's Scientific Publications in the Literature (known citations)

I accept the candidate's "*List of citations*", which is made in detail and complete and contains all the necessary information. However, the way they are presented makes it difficult to read and extract the necessary scientometric information. This list and the table to it reflect **64 citations of 20 publications** with his participation (one publication was cited 18 times, one - 15, one - four times, two - three times, six - twice and the other publications once).

4. General characteristics of the applicant's activities

4.1. Scientific and applied scientific activity

I accept the declaration made by the applicant in the "*Reference for original scientific and applied scientific contributions*" that "**the list of all scientific publications includes a total of 75 titles, of which 53 articles in international journals and series and 22 articles in refereed collections of international conferences**". I accept the publications of the candidate for participation in the competition", including **44 titles, five of which are in editions with impact factor (three - Q1, one - Q3, one - Q4) and 25 in editions with SJR**. These publications do not repeat those previously submitted by the candidate for the acquisition of the educational and scientific degree "Doctor" and for the academic position "Associate Professor". A review of the candidate's publications for participation in the competition shows that the candidate has two separate publications submitted for the competition. The co-authors of Dr. Ivan Lirkov have a diverse geographical location. I have no doubt about the personal contribution of the candidate in each of the publications. The main results of the candidate are in the field of the announced competition, are presented in detail, in-depth and understandable in the author's reference and can be determined in several sub-areas:

(1) *Methods for approximate solution of two-dimensional and three-dimensional boundary value problems (Stokes equation; systems of partial differential equations of convection-diffusion type; problems of elasticity theory; Maxwell's equations; heat transfer equation). (publications under numbers 1 - 7, 9, 13, 18, 22, 31 and 41);*

I accept as credible the candidate's statement that articles [1-7] have been published in specialized scientific journals and are on the topic "Parallel algorithm for numerical solution of two-dimensional and three-dimensional Stokes equation for incompressible fluid" and that these publications are equivalent to monographic habilitation thesis with this title. Based on a singular perturbation of the Navier-Stokes equation, in which the Laplace operator is replaced by a directional division operator, a new parallel algorithm for numerical solution of the Stokes equation for incompressible fluid is developed, using a directional separation method. Thus, instead of solving the Poisson equation in the projection schemes, a series of one-dimensional second-order boundary value problems are solved.

In other articles in this area have achieved new results related to:

- the numerical solution of systems of partial differential equations of the second order of convective-diffusion type [9];
- the study of the parallel properties of circular block factorization (CBF) algorithms for solving systems with poorly conditioned dilute matrices [13];
- comparative analysis of parallel algorithms using preconditioners based on MIC (0) and CBF factorization [18];
- solving three-dimensional linear problems from the theory of elasticity [13, 18];
- parallel implementation of the conjugate gradient method with a preconditioner (modified incomplete factorization MIC (0)) for solving the systems of partial differential equations arising from the numerical homogenization of human bone microstructures [22];
- computer modeling of the processes during operation of a high-frequency interfering portable device for non-contact removal of blood-sucking ectoparasites [31];

- computer modeling of radio-frequency thermal ablation of liver tumors, which includes thermal and electrical processes in the liver tissue [41];

In solving all the considered problems, high-performance computer architectures of different types (with shared memory, distributed memory, clusters) were used, and well-functioning algorithms for the respective class of supercomputer architecture were created.

(2) *Methods and algorithms for solving optimization problems (publications under numbers 11, 16, 36, 40, 43 and 44);*

Very good results have been achieved on this topic, published in renowned journals and papers at recognizable international conferences, which include:

- numerical algorithms for studying the spatial arrangement of amino acids in protein molecules [11, 16];
- experimental study of the performance of the parallel execution of an algorithm for image reconstruction [36] and image reconstruction, by means of Anscomb transformation for solving a convex optimization problem with constraints [40]. The developed algorithm was tested on real high-resolution tomographic images generated by an industrial computed tomograph Nikon XTH 225. Numerical experiments were performed on the Avitohol supercomputer at IICT-BAS and a comparative analysis was performed [44];
- algorithms and computer modeling using modern infrastructure to optimize energy management in a building. An architecture of a solution that uses data from sensors to control the state of the object is presented [43].

(3) *Parallel algorithms and applications on distributed computing systems (publications under numbers 8, 10, 12, 14, 15, 17, 19-21, 25, 26-30 and 32-34);*

Here are presented and commented all the most important achievements of Dr. Ivan Lirkov in the field of new methods and algorithms related to the use of state-of-the-art high-performance computing, which he shows that he fully deserves the academic position of "professor". In short, his achievements can be summarized as follows:

Research related to the use of Grid resources, in particular finding approaches in which teams of agents facilitate the mediation and management of Grid resources. Development

of an algorithm enabling software agents to be applied in ADAJ (an application in Java developed to run distributed applications in Java). Approaches to using teams of agents as resource brokers and network managers and to join agents to a team, as well as offering an agent-based system that can interact with an actual Grid middleware. Creating an algorithm to summarize existing efforts to create a Grid ontology and basic agent-Grid integration. Create a model for running various Grid applications on distributed computing systems, using a system of agents for the negotiation process between the user and the owner of the computing resources. Modification and extension of the CoreGRID ontology to become a central part of the project developed with the participation of the candidate, aiming at the development of an agent-based intelligent Grid middleware at a high level. The three ontologies have been created: (a) AiG Grid Ontology, which is a direct modification and extension of the CoreGrid ontology; (b) AiG Conditions Ontology and (c) AiG Messages Ontology, which result from the need to facilitate the negotiation of contracts. Developed agent-based intelligent middleware for Grid. It is based on teams of agents such as resource brokers and managers. A method for applying ontologically presented knowledge in support of Grid users has been proposed. An algorithm for parallel realization of three-dimensional discrete transformation on a computer system in which the communications between the computing nodes are performed in a three-dimensional toroidal network has been created. The use of an agent-based infrastructure for packet distribution and management in a Grid environment has been studied. A solution support system based on ontological representation and semantic technologies has been designed. In particular, the case where the Grid / Cloud user describes his resource requirements as an expression of an ontology class is considered, while the instances of the same ontology represent available resources. Most of the results achieved here have been achieved with colleagues from Poland and in the framework of bilateral cooperation.

(4) *New information technologies (publications under numbers 23, 24, 35 and 37-39)*

- Two nonlinear methods for generating pseudorandom numbers in the interval $[0, 1)$ are considered, namely a quadratic congruent generator and an inverse congruent generator. The combinations of a number of Van der Corput with the considered nonlinear generators are analyzed. [23].

- The b-adic diaphony is considered as a tool for measuring the uniform distribution of rows, as well as for studying pseudo-random properties of rows in quasi-Monte Carlo methods [24].
- Algorithms have been developed for the use of sensor data from smartphones and in-depth training techniques for real-time transport mode detection directly on the telephone [35 and 37].
- The basis of a control system for access control in a port terminal, based on the application of semantic technologies, has been created. The proposed system is based on an introduced and uses a modified version of the semantic application OntoPlay. The latter allows non-specialists to easily make the necessary modifications to the ontology [38].

Due to co-authorship with the candidate I will not review articles with numbers 2, 6, 36 and 41.

The scientific production of the candidate shows that she is a well-established, highly qualified scientist in the field of the announced competition, both in theoretical and applied aspect.

4.2. Educational activities (work with students, PhD students and postdoctoral)

In the submitted documents for the competition I do not find an explicitly indicated educational and pedagogical activity with students. Both in the attached documents and on the personal page of the candidate on the page of the section only his work as a teacher in PMG Burgas is indicated (see above). However, from our many years of joint work, I can point out that he has been a lecturer in various training courses related to the competition, mostly in IICT, but also abroad, for example, in a course on high-performance computers at the Catholic University of Nijmegen, The Netherlands.

4.3. Management and participation in research projects

I accept as credible the presented information about the management and participation of the candidate in research projects on the basis of submitted hand-signed declarations by their leaders - manager of six projects and participation in 17 projects.

4.4. Contributions (scientific, scientific, applied)

The scientific production of the candidate shows that he is a well-built, highly qualified scientist with significant scientific and applied contributions in the field of computational mathematics,

mathematical and computer modeling in various practical areas, both theoretically and applied. Scientific, scientific-applied or applied contributions can be found in each of the publications presented by Ivan Lirkov. All such are duly and comprehensibly described by him in the Summaries of scientific publications for participation in the competition for professor and Reference for original scientific and scientific-applied contributions, with which I fully agree and do not consider it necessary to retell again. Personally for me, the most representative are the results related to:

- (1) new and improved numerical methods and algorithms for solving systems of second-order partial differential equations of convection-diffusion type using a generalized conjugate gradient method and discrete Helmholtz preconditioners;
- (2) parallel algorithms for numerical solution of two-dimensional and three-dimensional Stokes equation for incompressible fluid and their implementation on massively parallel computers, clusters of multicore nodes and hybrid high-performance computing systems;
- (3) creation of an algorithm for parallel realization of three-dimensional discrete transformation on a computer system in which the communications between the computing nodes are performed in a three-dimensional toroidal network.

5. Assessment of the applicant's personal contribution

I have no doubt about the personal contribution of the candidate in each of the publications presented.

6. Critical notes

I have no critical remarks that would be relevant to determining my position and conclusion on this competition. However, I will mention a few things of a technical nature, some of which have made my work at least difficult in preparing this review: (a) The structuring of the information on the citations observed by the applicant does not facilitate the extraction of scientometric information, but on the contrary makes it very difficult; (b) I wonder why the list of peer-reviewed literature should have appeared a second time, in the order of the text in the "Reference for Original Scientific and Applied Contributions"; (c) some technical and other inaccuracies are noted in the various attached documents, such as the marked degree "mathematician" for the completed education in

FMI, and not "master of mathematics", etc.; (d) the submission of a list of all the applicant's publications would complete its submission and provide additional information.

7. Personal impressions

I know Ivan Lirkov from our joint work in the section "Scientific Calculations" and its precursorя of ICT and its precursorя. I can confidently say that he has built himself up as an excellent, highly qualified specialist in his field of competence.

8. Conclusion

All the written above forms in me a positive attitude towards the candidate and I suggest **Assoc. Prof. Dr. Ivan Dimov Lirkov TO BE ELECTED "PROFESSOR"** in the field of higher education 4. Natural sciences, mathematics and informatics, professional field: 4.5 Mathematics, scientific specialty: "Computational Mathematics (High Performance Methods and Algorithms)"

September, 2021

