

OPINION

by: Prof. DSci. Svetoslav Marinov Markov, IMI-BAS

Re: competition for the occupation of the academic position „Professor” in IICT-BAS

General information about the competition. At a meeting of the Scientific Council of IICT - BAS, minutes No. 7 of 10.07.2019 and an order of the Director of IICT - BAS, No. 209 / 16.08.2019, I was elected a member of the Scientific Jury in connection with the selection of "Professor" for the needs of IICT - BAS in the field of higher education 4. Natural sciences, mathematics and informatics, professional field 4.5. Mathematics, specialty Mathematical modeling and application of mathematics (in ecology). The competition for the occupation of the academic position of "Professor" for the needs of section "Scientific Computations" at IICT - BAS has been announced in State Gazette no. 49 / 21.06.2019. The only candidate to appear at the competition is Assoc. Prof. Dr. Krasimir Todorov Georgiev. All required documents and materials are presented: E1. Autobiography; E2. A copy of the diploma for the Doctor degree; E3. Certificate of Internship in the specialty; E4. List of scientific publications on the competition; E5. List of citations; E6. Abstracts of the scientific publications on the competition - in Bulgarian and English; E7. Copies of all scientific publications of the competition; E8. Information for the implementation of the minimum national requirements under Art. 2b, para. 2 and 3 and the requirements of the IICT under Art. 2b, para. 5; E9. Reference to original scientific and applied scientific contributions; E10. Declaration of absence of plagiarism in scientific works; E11. Evidence under item E8; E12. List of selected scientific publications for the period of work at BAS. The documents and materials presented are reliable and well designed.

Short details of the applicant. Assoc. Prof. Dr. Krasimir Todorov Georgiev was born on 14.04.1953. In the period 197-1978 he was a student in the Faculty of Mathematics and Mechanics of Sofia University "St. Kliment Ohridski ", graduated as Master of Mathematics with a specialization in mathematical modeling. He worked at the Bulgarian Academy of Sciences from 1979, until 1987 he was an assistant professor at the Institute of Water Problems at BAS. He received his Doctorate degree in 1984. From 1987 until now he is working at IICT - BAS as assistant (1987 - 1996) and associate professor (1996 - present). The scientific interests of Assoc. Prof. Dr. Krasimir Georgiev are in the following fields: mathematical and computer modeling; numerical methods for discretization of partial differential equations; numerical methods of linear algebra - iterative methods and preconditioners; scientific computations; parallel numerical methods, algorithms and software for their implementation on supercomputer architecture platforms. He was the head of several bachelor's and master's specializations.

Educational activity. Assoc. Prof. Dr. Krasimir Georgiev taught students: in Numerical Methods (1890-91), FMI-SU); in linear algebra and analytical geometry, mathematical analysis, numerical methods - Southwest University, Blagoevgrad (1992-99); in numerical methods - Burgas Free University (1999-2000); in "Parallel Information Processing (SPO) Systems" and "High Performance Systems and Algorithms (VPSA)" - UniBIT Sofia (2013-2019).

Organizational and project activity. Assoc. Prof. Dr. Krasimir Georgiev was Head and Deputy Head of many internal, national and international projects; he was a senior executive at IICT-BAS and its previous institutes, incl. two terms director, he was a chairman of the Assembly of Scientists at IICT, since 1996

has been Deputy Head of the “Scientific Compyttions” Section of IICT-BAS; He was chairman of the Attestation Committee, member of the General Assembly of BAS, member of the Expert Committee on Mathematics and Informatics at the National Scientific Research Fund (NSF).

Scientific and applied scientific activity. I). General description of the publications submitted for the competition. Assoc. Prof. Krasimir Todorov Georgiev has presented fifty-one (51) scientific publications, both in electronic pdf and on paper. The submitted publications on the competition did not participate in the procedure for acquiring a doctorate and associate degree. All publications submitted are articles published in journals and periodicals, referenced and indexed in world-renowned databases, as follows: publications in journals with IF: 22; publications in editions with SJR: 25.

Scientific and applied scientific activity. II). Scientific and applied scientific contributions. The scientific contributions of Assoc. Prof. Krasimir Todorov Georgiev are divided into two main groups of scientific fields: group (A) and group (B), with group (B) comprising four subgroups (B1) - (B4) as follows: (A) Scientific publications on groundwater modeling and removal of pollutants in porous media; (B) Scientific publications in the following four areas: (B1) Mathematical and Computer Modeling of Air Pollution Transfer Processes. The relationship between air pollution and climate change. Simulations on various supercomputer architectures; (B2) Mathematical and computer modeling of processes and phenomena in mechanics, medicine, etc. with parallel computer architectures; (B3) Richardson extrapolation studies and Runge-Kuta methods; (B4) Studies related to seismic construction mechanics problems. Below, I will comment on the submitted papers by groups. The notations of the individual publications and groups are as in the enclosed applicant’s reference to his original scientific and applied scientific contributions and his NACID card.

Group (A). It consists of five (5) scientific publications in journals referenced and indexed in world-renown databases. The group is equivalent to a habilitation work. This group includes the first five titles (V1 - V5) of the presented publication list. The articles in this group are co-authored with Assoc. Prof. Ivan Georgiev and Dr. Konstantinos Liolios of Democritus University of Thrace, Xanthi, Greece (and his associates) and are published in the period 2012 - 2018. The articles refer to a computational approach for modeling groundwater and removing pollutants in porous media. Rehabilitation procedures in horizontal underground wetlands are described. Real experimental data obtained from facilities of the Laboratory of Ecological Engineering and Technology (LEET) at Democritus University of Thrace (DUTH), Xanthi, Greece are simulated for biochemical oxygen consumption (BOD) and removal of the total phosphorus (TP) in wetlands of horizontal subsoil flows (HSF CW). Package MODFLOW is used for numerical simulation. Generally speaking, group (A) of articles is devoted to theoretical and applied research on the design and use of artificial wetlands in soil for environmental purposes. The scientific and applied research results published in the above-mentioned group (A) articles can be summarized as follows: A computational model for the simulation of total phosphorus (TP) removal in currents flowing in horizontal underground wetlands (HSF CWs) has been created. Analysis of simulated biochemical oxygen demand (BOD) data in horizontal subsurface wetlands is performed. An optimal reaction model is selected to account for the geothermal effects. A simplified numerical model for the simulation of geothermal effects in the processes under consideration in porous media is developed. Uupper and lower bounds of the solution are established taking into account the measurement uncertainty in some of the input parameters, that is, input sensitivity analysis has been performed.

In addition to group (A) classified as habilitation work, the applicant presents one more group (B) of 46 articles, which he divides into 4 subgroups as follows.

(B1) Mathematical and computer modeling of airborne contaminant transfer processes. Relationship between air pollution and climate change. Simulations on different supercomputer architectures. There are 20 articles in this group [1–3, 6, 8 - 11, 13, 14 - 17, 19, 21, 22, 36, 41, 44, 45]. Almost all of these articles (except articles number 2 and 8) are co-authored with the Danish scientist of Bulgarian origin Prof. Zahari Zlatev. This group of articles is devoted to mathematical models for the study of air pollution, offering sustainable and reliable management strategies for maintaining air pollution levels below established critical thresholds. For this purpose, large mathematical and computer models are used involving a large number of physical and chemical processes represented in much detail. The results presented in section (B1) are due to longlasted collaboration with Dr. Zahari Zlatev from the National Institute for Environmental Conservation in Roskilde (now a department of the University of Aarhus, Denmark) on the creation and refinement of the Danish Eulerian model for the transmission of pollutants in the air known as UNI-DEM. Some of the presented works are in collaboration with Prof. Ivan Dimov and Dr. Tsvetan Ostromski of IICT-BAS. These studies began around 1995 with the creation of a model version of the vector supercomputer Cray C92A. When UNI-DEM is used with high resolution (small step on spatial variables), extra large computational tasks are generated. Splitting methods are used to efficiently solve the resulting system, which leads to the solution of a series of simpler problems. Sub-process separation is used in UNI-DEM. Thus, instead of solving the originally obtained system, systems for the corresponding subtasks are solved. A version of UNI-DEM was developed with the participation of K. Georgiev, I. Dimov, and Ts. Ostromski, which is adapted to work on computers with a cluster organization, where commands from the OpenMP library are used in nodes with shared memory. The proposed version makes the UNI-DEM computer code portable between different types of parallel supercomputers. The organization of the “fast memory” on different computers requires additional tuning of the parameters of the different modules. The impact of future climate change on high levels of air pollution, especially on some levels of air pollution with ozone in Bulgaria, has been investigated using computer modeling.

(B2) In this group the candidate submits 17 articles [3 - 7, 12, 20, 23, 24, 26, 29, 32, 34, 35, 37, 39, 46]. In their examination I exclude 6 articles [4, 6, 7, 23, 29, 34] which are introductory editorial notes to special issues of journals and periodicals. The other 11 articles in this group [3, 5, 12, 20, 24, 26, 32, 35, 37, 39, 46] are devoted to mathematical and computer modeling of processes and phenomena in mechanics, medicine, etc. on parallel computer architectures. Assoc. Prof. Dr. Krassimir Georgiev participated in the creation and refinement of existing mathematical and computer models that help the development of renewable energy sources and increase energy efficiency (wind turbines), medicine (osteoporosis, haematological diseases, haematologists, haematologists , tumor ablation), environmental protection (airborne pollutants and soil reclamation) based on modern information and communication technologies. New versions of software for massively parallel computers as well as clusters of multi-core nodes have been created. Hybrid parallelization based on MPI standards (for parallel shared memory computers) and OpenMP (for parallel shared memory computers) is used. Fast, robust and reliable methods for solving systems of linear algebraic equations have been developed when the relevant computer codes have to be run on high-performance modern computers. Since the

coefficients of systems matrices are usually diluted (ie, most of their elements are zeros), the first requirement is to use this dilution effectively. However, this is usually not enough when the systems are very large. New results have been obtained based on the construction of precursors using approximate LU factorization and their use in efforts to further increase the efficiency of the calculations. Poisson noise occurs in many areas of image processing, such as computed tomography, in which data collection is based on counting particles that strike the surface of the detector. Using transform-stabilizing variations, Poisson noise can be approximated by a Gaussian for which classical noise filters can be used. An experimental study was performed on the performance of the parallel execution of the Poisson image recovery algorithm. The implementation has been tested for high resolution radiographs. A new algorithm has been developed for dividing a domain area computation domain (Domain Decomposition, DD) with its overlay and its implementation on parallel computers with shared and distributed memory, including clusters of workstations. The problem under consideration is the numerical solution of 3D elastic systems, but the basic ideas, algorithms and codes are applicable to 3D elliptical problems with given boundary conditions and discontinuous coefficients. The system of linear equations, which must be solved after discretization by the finite element method, is symmetric and positively defined, and the preconditioned conjugate gradient method is used, the preconditioner being constructed by the subdivision method. The proposed algorithm is highly parallelizable.

(B3) This group of nine (9) papers is devoted to studies related to Richardson extrapolation and Runge-Kutta methods in solving computational problems [13, 18, 25, 27, 28, 31, 38, 42, 43]. In this section the result of the candidate's work are done in cooperation with prof. Zahari Zlatev, as well as with Prof. Ivan Dimov from IICT-BAS, with Prof. Istvan Farago and Dr. Agnes Havasi from MTA-ELTE Numerical Analysis and Large Networks Research Group, Budapest, and the Department of Applied Analysis and Computational Mathematics, Eotvos Lorand University, Budapest.. The well-known Crank-Nicolson scheme is used for the advection equations that are an integral part of many mathematical models arising in science and technology. It is shown that the accuracy of the calculated results can be improved when the Crank-Nicolson scheme is combined with Richardson extrapolation. Two theorems related to the accuracy of calculations are formulated and proved. The usefulness of the combination consisting of the Crank-Nicolson scheme and Richardson extrapolation is illustrated by numerical examples. Not only is the combination of Richardson extrapolation with Runge-Kutta's pre-selected methods more accurate than the basic numerical methods, but their areas of absolute stability are also much larger. Sometimes this fact allows us to take bigger steps during the numerical solution when using Richardson extrapolation. The numerical solution of the multidimensional advection equations uses a Crank-Nicolson type scheme, which is of the order of two with respect to all independent variables. Usually, the order of precision of any number scheme can be increased by one when using Richardson's well-known extrapolation. In this particular case, it is proved that the order of precision of the combined numerical method, the Crank-Nicolson scheme and Richardson extrapolation, is not three but four. New algorithms have been developed to effectively apply Richardson's two-fold extrapolation assuming that systems of ODEs are solved numerically by explicit Runge-Kutta methods. The computational cost per step of these new numerical methods is higher than the cost per step of the underlying basic methods.

(B4) This group of four (4) articles contains studies related to seismic structural mechanics tasks [30, 33, 35, 40]. In this direction, the candidates co-authors are mostly Prof. Asterios Liolios and Dr. Angelos Liolios from Democritus University of Thrace (DUTH), Xanthi, Greece. K. Georgiev participated

in a numerical study of the seismic analysis of high-rise reinforced concrete and (RC) structures that have been degraded due to extreme environmental effects and reinforced by cable elements. The effects of multiple earthquakes on such RC building frames are calculated. Damage indices are evaluated to compare the seismic response of structures before and after upgrading by reinforcing the cable elements and thus selecting the optimum version of reinforcement. Studies have been carried out on the seismic reinforcement of civil engineering systems of adjacent reinforced concrete (RC) structures. A numerical approach is presented to evaluate the impact of a shock (seismic interaction) on the response of such adjacent structures to the excitation of multiple earthquakes. The seismic renovation of buildings declared as cultural heritage in the wake of multiple earthquakes has been calculated and analyzed, using materials and methods in the context of sustainable construction. A computational approach is proposed for reconstruction of Reinforced Concrete Structures that have been degraded by extreme actions.

Conclusions from the analysis of the applicant's publishing activity. Assoc. Prof. Dr. Krasimir Georgiev has considerable publishing activity, which is described objectively and in detail in the presented report on scientific and applied scientific contributions. The majority of his publications are in collaboration with one, two or more co-authors, but his involvement and contribution to these works is beyond doubt. All entries in the contest are original in nature, absent any form of plagiarism. With his knowledge and skills in numerical methods and algorithms for large-scale tasks, in adapting software for high-performance computing systems, as well as in a number of applied environmental fields and methodologies for mathematical modeling, the candidate is an indispensable member of the authors' teams in the publications presented. Particularly valuable is the use of actual experimental data obtained in a number of publications, e.g. those of group A. According to Part G of the requirements of IICT-BAS for the minimum number of points, the candidate collects about five times more than the required 260 points. Assoc. Prof. Krasimir Georgiev is well known to the world's scientific agencies, giving him an h-index of 11.

Citations in scientific publications, referenced and indexed in world-renoun scientific information databases (Web of Science, Scopus). The list provided contains 52 citations of Krasimir Georgiev's articles published in publications that have been referenced and indexed in the Web of Science and Scopus scientific databases.

Of these, 16 are in articles with IF in Q1. Thus, under Part E of the minimum score requirement, the applicant collects more than twice the 140 points required. The minimum requirements for Part F of the requirements of IICT - BAS are satisfied. For this part, the candidate compensated for the lack of a PhD degree and defended a PhD student with a successful project activity that earns 590 points, which is almost 4 times higher than the required 150.

Opinion on the presence or absence of plagiarism. No scientific plagiarism has been demonstrated in the papers submitted for evaluation.

Personal impressions. I know Assoc. Prof. Dr. Krasimir Georgiev from joint participation in conferences and his participation in an international project with teams from Switzerland, Bulgaria and Northern Macedonia, in which I was the coordinator from Bulgaria (Swiss NSF Institutional Partnership Project No. 7 IP 65642 (SCOPES Program): Establishing CSE in Bulgaria and Macedonia, 2002-2004.). Krasimir Georgiev is extremely humble, responsive, well-meaning, open to collaboration and scientific

collaboration, with excellent organizational and communication skills. Over the years, I have followed his research-related publications. I reviewed his article proposed for a collection under my editorship (1993).

Final conclusion. My assessment of the scientific, applied and teaching activity of Assoc. Prof. Dr. Krasimir Todorov Georgiev is definitely positive. This activity corresponds to the indicators for occupying an academic position of "professor", in accordance with the requirements of Art. 2b, Art. 29, and Art. 29b. of the ZRASRB, the PPRASRB, the Regulations for the implementation of the ZRASRB of BAS and IICT-BAS. The minimum national requirements under Art. 2b, para. 2 and 3 and the requirements of IICT-BAS under Art. 2b, para. 5 and Art. 29 para. 3 are fulfilled.. I believe that the Scientific Jury can and should propose to the Scientific Council of IICT-BAS to elect Assoc. Prof. Dr. Krasimir Todorov Georgiev for the occupation of the academic position of "Professor" in the field of higher education 4. "Natural Sciences, Mathematics and Informatics", professional field 4.5 Mathematics, scientific specialty "Mathematical modeling and application of mathematics (in ecology)".

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7.10.2019
Sofia

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