REVIEW

on the competition 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 01.01.13. Mathematical modeling and application of mathematics (in ecology) declared in the State Gazette issue. 49 / 21.06.2019 for the needs of section "Scientific calculations" in IICT - BAS.

Candidate: Assistant Professor Dr. Krasimir Todorov Georgiev, Section "Scientific Calculations", IICT - BAS, sole candidate

Reviewer: Corresponding Member Kostadin Ganchev Ganev, NIGGG – BAS

1. General data on the career and thematic development of the applicant

Krasimir Todorov Georgiev was born on 14.04.1953. In 1978 he graduated from the Faculty of Mathematics and Mechanics of Sofia University "St. Kliment Ohridski "with a Master's degree in mathematics with a specialization in mathematical modeling. From 1979 to 1987 he worked at the Institute of Water Problems (IWP) of the Bulgarian Academy of Sciences, consistently occupying the positions of Assistant, Senior Assistant, Chief Assistant. In the IWP, he conducts research in the field of mathematical and computer modeling of dams and temperature distribution in them. Participates in IWP and national projects. In 1984 he received his PhD degree.

In 1987 he went to work at IICT - BAS, where in 1996 he became an associated professor.

The main directions in the professional path of Assoc. Prof. Georgiev are related to researches in the field of mathematical and computer modeling: Numerical methods - discretization of partial differential equations; Numerical Methods of Linear Algebra - Iterative Methods and Converters; Parallel numerical methods, algorithms and software for their implementation on supercomputer architectures; Computer simulations of specific phenomena and objects, especially in the field of environment, etc.

Along with the research, Assoc. Prof. Georgiev has an impressive scientific-organizational activity. He was the head and deputy manager of internal, national and international projects; held different administrative positions at IICT - BAS and its previous institutes, incl. two terms "deputy director ", chairman of the General Assembly of the scientists in the ICT, chairman of the accreditation committee, member of the General

Assembly of the BAS; member of the Expert Committee on Mathematics and Informatics at the Research Fund, and others.

2. General description of the materials presented

2.1. Full-text publications and reports

The candidate has submitted a list of all his publications and a separate list of publications with which he appears in this competition. The list of all publications includes 84 papers published in scientific journals and 29 articles in books, conference proceedings and scientific reports.

The publications with which K. Georgiev appears in this competition are a total of 51 are in scientific journals Of these, 48 are in publications that have been referenced and indexed in world-renowned scientific information databases and 3 are in book chapters.

The total number of articles by Assoc. Prof. Georgiev in journals with IF is 25, and of articles in publications with SJR - 28.

Of the articles with which Krasimir Georgiev participated in this competition, the publications in IF magazines were 22 (13 of them in Q1, 3 in Q2, 1 in Q3, 5 in Q4). The number of articles in editions with SJR is 25.

It can be seen that the main number of papers in prestigious publications were written after the first habilitation of Assoc. Prof. Georgiev.

The publications with which Krasimir Georgiev participates in this competition are enclosed in full text, as well as summaries of them in Bulgarian and English.

2.2. List of noted citations of publications and reports in full text with author / co-author Assoc. Prof. Dr. Krasimir Georgiev.

The list provided contains 52 citations of articles by Krasimir Georgiev 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.

The quotations of the works of Assoc. Prof. K. Georgiev show that his work is well known and reflected in the scientific literature, including in prestigious refereed journals.

2.3. Research projects with the participation of Assoc. Prof. Dr. Krasimir Georgiev.

K.Gorgiev has participated in 10 international and 6 national scientific projects. He has managed 4 national scientific projects and has been the leader of the Bulgarian team in 5 international scientific projects.

3. General characteristics of the professional activity

As already stated above, Prof. Georgiev's professional activity is related to research in the field of mathematical and computer modeling: Numerical methods - discretization of private differential equations; Numerical Methods of Linear Algebra - Iterative Methods and Preconditioning; Parallel numerical methods, algorithms and software for their implementation on supercomputer architectures; Computer simulations of specific phenomena and objects, especially in the field of environment, etc. In the professional activity of Assoc. Prof. Georgiev, the whole chain can be traced - from theoretical studies in the field of numerical methods, through the creation and development of computer models to the study of various real objects and processes by means of computer modeling.

4. Pedagogical activity

Prof. Krasimir Georgiev has a rich teaching activity:

- 1984 - 1986: part-time lecturer at the Technical University, Sofia, where students are taught in the following disciplines: linear algebra and analytical geometry, mathematical analysis and numerical methods
- 1990 - 1991: part-time lecturer at FMI - Sofia University "St. Kliment Ohridski, where he teaches numerical methods to students in the discipline numerical methods
- 1992 - 1999: part-time lecturer and assistant professor, later associate professor at half-state at Southwestern University, Blagoevgrad, where he teaches students in the following disciplines: linear algebra and analytical geometry, mathematical analysis of numerical methods
- 1999 - 2000: Assistant Professor at Burgas Free University, Burgas, where he teaches numerical methods to students in the discipline
- 2013 - 2019: part-time lecturer and Associate Professor of half-staff at UniBIT Sofia, where he teaches students in the following disciplines: Information Parallel Processing Systems and High Performance Systems and Algorithms

5. Analysis of scientific and applied scientific achievements

Assoc. Prof. Krasimir Georgiev defines several groups of his scientific contributions. These are listed below, with an estimate of which category, in the opinion of the reviewer, should be attributed to:

(A) This group includes the first five titles (B4.1 - B4.5) of the submitted publication list. They are dedicated to research, theoretical and applied, in the field of design, study and

use of artificial wetlands (CWs), which are a possible solution to the problem of domestic wastewater treatment. The research done concentrates on the choice of the optimal reaction model to take into account the geothermal effects. The goal is to optimally design CW, both from environmental and financial point of view. The results that have been published in the articles mentioned above can be structured in the following chapters:

A.1. Analysis of the process of transfer of polluted water in porous media and removal of pollutants in them

A detailed analysis of existing mathematical and computer models and algorithms has been made.

A.2. Numerical modeling and computer simulations of the processes during the transport of contaminated water using available experimental data. Visual MODFLOW computer code. Test simulations.

A computer model was created based on the solution of inverse problems by which the corresponding linear and nonlinear absorption models are obtained for simulating the removal of total phosphorus in currents flowing in the horizontal underground wetlands.

For the purpose of computer simulations and experiments, the computer code Visual MODFLOW is installed and verified. Experimental data from horizontal subsurface wetlands, which have been actively monitored for two years in Xanthi, Greece have been used to verify the results of computer simulations.

The results obtained can be defined as a creation of new research methods.

A.3. Analysis of the data obtained from the test simulations on the biochemical oxygen demand (BOD) in horizontal subsurface wetlands.

Additional computer experiments were performed to determine the values of the parameters of the ongoing processes, with the simplification of the task to a first-order linear task for determining the biochemical oxygen consumption.

The results obtained can be defined as creating new methods of inquiry and obtaining new facts.

A.4. Pre-selection of an optimal reaction model to take into account geothermal effects.

Geothermal effects can significantly alter the effects of horizontal artificial wetlands. A simplified numerical model for the simulation of geothermal effects in the processes under consideration in porous media is developed. This simplified model solves a system of nonlinear partial differential equations describing the transport of pollutants and their removal

at certain temperature values. The computer experiments made allow us to choose the optimal values of certain parameters.

The results obtained can be defined as creating new research methods and obtaining new facts.

A.5. Determining the solution upper and lower boundaries for accounting for uncertainty in some of the input parameters.

Cases of removal of more than one pollutant in an artificial wetland have been investigated. Mathematically, this problem leads to the solution of a system of nonlinear partial differential equations. Using the Visual MODFLOW computer code, the upper and lower bounds of the uncertainty of some of the input parameters of the system of nonlinear differential equations are determined.

The results obtained can be defined as obtaining new facts.

B.1 Mathematical and Computer Modeling of Air Pollution Transfer Processes. The relationship between air pollution and climate change. Simulations on different types of supercomputer architectures. [1–3, 6, 8 - 11, 13, 14 - 17, 19, 21, 22, 36, 41, 44, 45]

Large mathematical and computer models, which reflect in full detail all the physical and chemical processes, are used to solve the problems of the chemical composition of the atmosphere. The use of such models leads to the solution of super-large computational problems. and in order to effectively create optimal strategies for reducing air pollution, model ensembles need to be run several hundred times on different computers.

The results presented in this section are the result of the author's many years of work, mostly with Dr. Zahari Zlatev of the National Institute for Environmental Protection in Roskilde (now a department of the University of Aarhus, Denmark) on development and improvement of new versions of the Danish Eulerian model of airborne pollutants (UNI-DEM). In some of the presented works also in collaboration with Prof. Ivan Dimov and Dr. Tsvetan Ostromski of IICT-BAS.

The version of the UNI-DEM computer model for use on parallel computers with common, shared, or mixed memory was developed based on the method of dividing the computational domain to subdomains. In most of the cases, a version of the model region separation by strips parallel to the abscissa is used. This version produces very good results with a relatively small number of processors, ≤ 120. The large number of processors in modern supercomputers is the motive for developing a new parallel version in which the subdomains are squares, i.e. a separation was made, both parallel to the abscissa axis and parallel to the ordinate axis. The MPI (Message Passing Interface) library is used for

communications between processors during program execution. Together with I. Dimov and Ts. Ostromski, a version of UNI-DEM has been developed that is adapted to work on computers with a cluster organization, where commands from the OpenMP library are used in nodes where memory is shared.

I completely agree with Krasimir Georgiev's statement that implementing and setting up such a complex model on every different computer is a non-trivial task. Versions of this model have been developed and used for various types of supercomputers: vector, parallel distributed memory computers, clusters, parallel shared memory computers, and parallel computers with two levels of parallelism. The DEM parallel code created using the standard MPI communication library is portable and demonstrates good performance and scalability on different types of vector and parallel computers.

In my opinion, the role of K. Georgiev in the creation of versions of UNI-DEM ifor use on parallel computers is extremely significant and has a character of a contribution. I would call these contributions the creation of new methods and research tools.

One of the important consequences of climate change is the potential danger of increasing concentrations of some pollutants, which can cause damage to humans, animals and plants. Computer simulation (model is UNI-DEM) investigates the impact of future climate change on high levels of air pollution and, above all, the increase of some ozone levels in Bulgaria. The sensitivity of pollution levels to variations in anthropogenic and natural emissions has also been investigated. The impact of future climate change on some high levels of ozone pollution that can cause damage to plants, animals and humans has also been studied.

These contributions by Assoc. Prof. K. Georgiev would be defined as obtaining new facts and enriching the existing knowledge with application in practice. The results have indisputable scientific and applied character as a basis for formulating decisions making for improving the quality of atmospheric air.

(B.2) Mathematical and computer modeling of processes and phenomena in mechanics, medicine, etc. with computer experiments on parallel computer architectures. [3 - 7, 12, 20, 23, 24, 26, 29, 32, 34, 35, 37, 39, 46]

Independently and in co-authorship Krassimir Georgiev participated in the creation of new and improvement of existing mathematical and computer models that help the development of renewable energy sources and increase energy efficiency (wind turbines), medicine (osteoporosis, hematological diseases, aneurysm, tumor ablation). New methods, algorithms and software tools have been created for tasks with large and ultra-large

dimension, hierarchical computer models for application in the research and design of complex materials and processes.

The vacuum freeze drying process is modeled by a system of nonlinear partial differential equations. New algorithms for numerical and computer modeling of the heat and mass transfer sub-model (coupled system) in the absorber chamber have been developed.

Radiofrequency ablation is a mild invasive technique for the treatment of liver tumors. New results have been obtained that relate to the mathematical modeling and computer simulation of the heat transfer process. Instead of regular discretization of the considered time interval, an adaptive time step procedure is applied to reduce the simulation time.

For the time-dependent Stokes equation on a finite time interval and on a regular rectangular grid, a new parallel algorithm was developed based on the method of division by directions. New versions of the developed software have been created aimed at executing on massively parallel computers as well as on clusters of multi-core nodes.

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. in an effort to further increase the efficiency of the calculations. New results have been achieved on the basis of the design of preconditioners using approximate LU factorization and preconditioners application in efforts to further increase the efficiency of the calculations.

Poisson noise appears in many areas of image processing, such as computer tomography. An experimental study of the performance of the parallel execution of the Poisson image recovery algorithm was performed. The implementation was tested for high-resolution radiograph images.

A new algorithm for Domain Decomposition (DD) has been developed with sub-domains overlay and implemented on parallel computers with common and shared memory, including clusters of workstations. The problem under consideration is the numerical solution of 3D elastic systems. 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, while the preconditioner is constructed by the DD method. The algorithm is highly parallelizable.

These contributions can be defined as creation of new methods and research tools, obtaining new facts and enrichment of existing knowledge with application in practice.

(B.3) Studies related to Richardson extrapolation and Runge-Kuta methods in solving important computational problems. [13, 18, 25, 27, 28, 31, 38, 42, 43]

The results presented in this section are the result of the work of K. Georgiev in cooperation with Dr. Zahari Zlatev, as well as with Prof. Ivan Dimov from IICT-BAS, with prof. Istvan Farago And Dr. Agnes Havasi from Eotvos Lorand University, Budapest, Hungary.

The Crank-Nicolson scheme is applied to approximate the advection equations. 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. It was proved that not only are the combinations 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. New algorithms have been developed for the effective application of Richardson's two-fold extrapolation on the assumption that systems of ordinary differential equations are solved numerically by explicit Runge-Kutta methods.

This contribution is essentially the development of a new numerical method.

(B.4) Investigations related to tasks arising from seismic construction mechanics. [30, 33, 35, 40]

In co-authorship with Prof. Asterios Liolios and Dr. Angelos Liolios from Democritus University of Thrace K. Georgiev conducts studies related to seismic reinforcement through cable elements (connections) of civil engineering systems of adjacent reinforced concrete structures that have been degraded by the environment. 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 presented for the reconstruction (strengthening) of existing reinforced concrete structures declared as cultural heritage that have been degraded due to external influences.

These achievements can be categorized as acquiring new facts and enriching existing knowledge with practical application.

In conclusion of this section of the review, I would like to declare that I fully accept the applicant's claims for scientific and applied scientific contributions.

6. Compliance with the minimum required points by groups of indicators for obtaining of the academic position "Professor"

The table below shows that Assoc. Prof. Dr. Krasimir Georgiev satisfies, and for most indicators far exceeds, the minimum required by the IICT points for the academic position of "Professor".

Indicator group	Minimum score according to the requirements of the IICT	Number of points scored by the applicant
А	50	50
Б	-	-
В	100	120
Г	260	1911
Д	140	416
Е	150	590

7. Conclusion

All of the above can be summed up in the assertion that Assoc. Prof. Krasimir Todorov Georgiev is an eminent specialist in the field of numerical methods, parallel numerical methods, algorithms and software for their implementation on supercomputer architectures; as well as in the field of computer simulations of specific phenomena and objects. Considering the creativity, experience, international recognition and practical activity of Krasimir Todorov Georgiev, I am firmly convinced that he is an undisputed candidate for the academic position of a professor in IICT in the field of higher education 4. Natural sciences, mathematics and informatics, professional field 4.5. Mathematics, scientific specialty 01.01.13. Mathematical modeling and application of mathematics (in ecology). With this, I suggest without any reservation, to the scientific jury to recommend to the SC of the IICT to award Assoc. Prof. Dr. Krasimir Todorov Georgiev the academic position of "Professor".

11.10.2019

Reviewer:

Corresponding Member Kostadin Ganchev Ganev