Review

for associate professor Todor Gyurov
in the competition for academic position "Professor"
in the professional field 4.5 "Mathematics"
scientific specialty "Mathematical modeling and application of mathematics (Monte Carlo and quasi-Monte Carlo algorithms and applications)"

Reviewer: Prof. Stefka Fidanova

By Order No. 178 dated 09.07.2019 of the Director of Institute of Information and Communication Technologies at Bulgarian Academy of Sciences, Prof. Galia Angelova, pursuant to Art. 4, para. 2 of the Law on the Development of Academic Staff in the Republic of Bulgaria (LDASRB) and decision of the Scientific Council of IICT-BAS (Minutes No. 7 of 10.07.2019) I have been appointed a member of the scientific jury under the procedure for the academic position of "Professor" in the professional field 4.5 "Mathematics" scientific specialty "Mathematical modeling and application of mathematics (Monte Carlo and quasi-Monte Carlo algorithms and applications)", announced for the "High Performance Systems, Networks and Algorithms" section of State Gazette issue 41 of 21.05.2019. As a member of the jury on 24.07.2019 I have received all the documents, attached to the application to the Director of IICT-BAS of the only candidate for the competition Assoc. Prof. Todor Vasilev Gyurov.

According to Law on the Development of Academic Staff in the Republic of Bulgaria, the rules for its implementation and the specific requirements introduced in the regulations of IICT-BAS, applicants must meet the following requirements:

1. Have acquired a doctorate degree in education and science;
2. Have held the academic position of "Assistant Professor" at the same or another higher education institution or scientific organization for at least two academic years;
3. Have submitted published monographs or equivalent publications in specialized scientific editions which do not repeat the ones submitted for the degree of PhD, the Doctor of Sciences and the academic position of Associate Professor;
4. Have submitted other original research papers, publications, inventions and other scientific and applied research works which are evaluated in aggregate;

5. Meet the national minimum requirements;
6. Not to have the lawful plagiarism proven in scientific works.

Associate Professor Todor Gyurov holds a dissertation for educational and scientific degree "Doctor" (HAC to the Council of Ministers, diploma № 26493 / 21.02.2000, commission 1, protocol № 9 of 17.12.1999) certificate No. 22467 of 8 June 2004. Associate Professor Gurov has 32 years of total work experience, of which 13 years as associate professor.

For Group B requirements, Todor Gurov submitted 6 publications, one with an impact factor in Q1, one in Q2, two in Q4, and two publications with an impact rank, the total score was 178 at the required 100.

For Group Г indicators, a total of 20 publications are presented, 16 of them are Impact Ranks, three are in the World Indexing and Referencing System, without Impact Factor or Impact Rank and one book chapter. The total number of points is 371 for the required 260.

Assistant Professor Todor Gyurov submitted 74 citations after acquiring the academic position of Assistant Professor visible in WoS / SCOPUS. The total number of points is 444 for the required 140 under indicator Д. He also has 174 other citations in dissertations and articles published in conference volumes.

Associate Professor Todor Gyurov was the head of the Bulgarian team of 7 international projects and coordinator of 4 national projects. He was a member of the scientific team of 7 international projects and 6 national projects. The total number of points is 630 for the required 150 under indicator E.

Prof. Todor Gyurov significantly exceeds the national requirements, as well as the specific requirements of BAS and IICT for the academic position of "professor".

The scientific papers presented by Associate Professor Todor Gurov are mainly in the field of Monte Carlo and Quasi Monte Carlo methods and related applications. The MC methods are a wide range of computational algorithms that use the repetition of random samples to obtain a numerical result. They are often used to solve physical and mathematical problems and are very useful in solving large problems when other mathematical methods are impossible or impractical. MC methods are especially useful for simulating phenomena with significant uncertainty in input information and systems with a large number of coupled degrees of freedom. MC methods are very important in computational physics as modeling of electron and radiation transport, in statistical physics molecular modeling, as an alternative to computational molecular dynamics. Quantum MC methods have applications in quantum mechanics. Some of the possible applications of this topic are in: semiconductor physics - to create new electronic devices; quantum calculations that lead to the creation of new computing devices for information processing. MC methods are widely used in

engineering for sensitivity analysis and quantitative probabilistic analysis in the design process. MC simulations provide answers to specific questions related to data analysis, statistical power, and to obtain the most accurate results in empirical studies.

The main contributions to his research can be summarized as follows:

1. Development of Monte Carlo and hybrid Monte Carlo algorithms for simulation of quantum transport and electronic transport in ultra-small devices in mixed mode (5 publications).

A Monte Carlo algorithm based on the use of a Markov chain back in evolutionary time was developed to solve the quantum-kinetic equation. Variance reduction techniques were applied to construct the algorithm to avoid singularity at the kernel. The equation describes ultra-fast quantum-wire transport with an applied electric field in a non-homogeneous case. The numerical results obtained allow us to investigate the intrinsic collision effect of the field from a physical point of view.

2. Development of the Grid application SALUTE (Stochastic ALgorithms for Ultrafast Transport in sEmiconductors) by integrating several Monte Carlo, quasi-Monte Carlo and hybrid algorithms for solving quantum-kinetic equations (4 publications).

SALUTE studies quantum effects during the femtosecond relaxation process of electron-phonon interactions in single-band semiconductors or quantum wires. The SALUTE application is adapted to run in the GLite middleware environment, which is an upgrade of the Linux operating system to make a computing cluster part of the Grid infrastructure.

3. Monte Carlo approach for the equation of rendering (Cook-Torrance model) and for restoring densities (2 publications).

A Monte Carlo estimator for the numerical calculation of the equation arising from the Cook-Torrance model was constructed and a priori estimates were obtained for the dyspepsia of the constructed MC random variable. An unknown density reconstruction method is presented, which includes the B-spline approximation, the least-squares method, and the Monte Carlo method for calculating integrals. The method is numerically compared with other statistical methods for density estimation.

4. Investigating the sensitivity of MC and quasi-MC algorithms for solving multidimensional integrals and integral equations with different random number generators and applying dispersion reduction techniques (4 publications).

A new variant of the "random walk on a sphere" method is described. This approach is new to the approximate solution of elliptic boundary value problems and leads to improved convergence over variants using pseudo random numbers and classical quasi-random series such as Holton, Sobol and

Forr. It investigates the sensitivity of the Monte Carlo class of reduced-variance methods for calculating multidimensional integrals to random number generators (quantum random number generator), pseudo random and quasi-random numbers. The numerical results obtained were compared using different techniques to reduce dispersion. Two types of congruent generators with permutation sequences are considered and tested for approximate calculation of multidimensional integrals and integral equations by Monte Carlo methods. The results show that they are suitable for this purpose. The Sobol series is considered and an algorithm for generating a displaced (agitated) row suitable for grid applications is presented. Estimates for the parallel efficiency and convergence rate of the corresponding quasi-Monte Carlo algorithm were obtained and compared with the MK algorithm using the parallel SPRNG library to generate parallel rows of pseudo random numbers.

5. Investigation of scalability and energy efficiency of intensive Monte Carlo and quasi Monte Carlo algorithms on supercomputer systems (7 publications).

The scalability of MC algorithms for solving quantum-kinetic integral equations is investigated. Numerical results for parallel efficiency and computational cost are presented. A new metric has been introduced to evaluate the efficiency of algorithms, which depends not only on the time of their execution, but also on the energy consumed, as well as the depreciation of the equipment (the effective life of the computer system). Energy efficiency estimates have been obtained in the study of linear algebra and semiconductor physics problems on heterogeneous HPC systems with refinement of penalty function. A new approach for the parallel generation of quasi random series has been developed. Parallel quasi-Monte Carlo matrix computing algorithms have been developed specifically optimized for Intel Xeon Phi accelerators. The parallel efficiency of inverting large sparse matrices was investigated to achieve optimal parallel efficiency. The parallel efficiency of inverting large sparse matrices was investigated to achieve optimal parallel efficiency. Quasi-Monte Carlo algorithms were created using OpenMP + MPI hybrid programming to store memory.

The applicant has played a leading role in building the national and regional Grid and HPC infrastructure over the last 20 years.

I have known the candidate for the competition for almost 30 years. I am fully convinced of his qualities as a researcher and a good organizer, which are the basis for further development in science.

CONCLUSION

According to the presented documents, the candidate Assoc. Prof. Todor Gyurov fulfills all the requirements of the LDASRB, of its Rules of Procedure and of the Rules on the Specific Requirements for Acquisition of Academic Degrees and Occupation of Academic Positions of BAS and IICT-BAS. I give a positive conclusion for the selection of Associate Professor Todor Gyurov in the competition for the academic position of "Professor" in the professional field 4.5 "Mathematics" scientific specialty "Mathematical modeling and application of mathematics".

I propose that the Scientific Jury unanimously vote on a proposal to the Scientific Council of the Institute of Information and Communication Technologies of the Bulgarian Academy of Sciences to select Assoc. Prof. Todor Vasilev Gyurov for the academic position of "Professor" in the professional field 4.5 "Mathematics" scientific specialty "Mathematical modeling and application of mathematics. "

23.08.2019