

## **Review**

**for the contest for taking the academic position of Associate Professor  
in professional track Physical Sciences (General Physics)  
for the needs of Sofia University “St. Kliment Ohridski” (SU), Faculty of Physics,  
declared in State Gazette, No. 54 from 29<sup>th</sup> June.2021**

The review is prepared by Prof. Habil. Dr. Krassimir Dimitrov Danov, corresponding member of the Bulgarian Academy of Sciences, from Faculty of Chemistry and Pharmacy as a member of the scientific jury of the contest for Associate Professor in professional track 4.1 Physical Sciences (General Physics), according to Order No. RD38-374 from 21<sup>st</sup> July 2021 by Sofia University’s Rector.

For participation in the declared contest **the only candidate who submitted application is: Dr. Plamen Veskov Petkov, Assistant Professor in Faculty of Physics of Sofia University “St. Kliment Ohridski”**

### **I. General description of the presented materials**

#### **1. Data of the application**

The presented documents by the candidate correspond to the requirements of the Law for Academic Staff Development in the Republic of Bulgaria (DASRB), the Regulation for the implementation of DASRB law, Regulation for Acquiring Academic Degrees and Positions in Sofia University “St. Kliment Ohridski”. For the participation in the contests, the only candidate, Dr. Plamen Petkov, presented a list, containing one monography, three chapters of books, 13 scientific publications, indexed in SCOPUS, nine scientific publications in proceedings of international conferences, 11 participations in international scientific conferences. There are presented other documents, such as official notes by the employers, project leaderships and other proofs evidencing that the candidate meets all requirements by the mentioned above law and regulations for the position of associate professor.

#### **2. Data of the candidate**

Doctor Plamen Petkov obtained two master’s degrees as follows: 1992 – master engineer-thermophysist (State Technical University, Saint-Petersburg, Russia) and 2011 – master in

physical chemistry (Faculty of Chemistry and Pharmacy in Sofia University “St. Kliment Ohridski”). During 2016, he obtained the PhD degree “doctor” in chemistry field “Macrokinetics” at Sofia University “St Kliment Ohridski,” Faculty of Chemistry and Pharmacy. He passed through three specializations in prestigious scientific units: two in Argonne National Laboratory (USA) and one in University of Illinois at Urbana-Champaign (USA). From 1992 to 2010, he worked in Kozloduy NPP, where he was employed at several manager positions from an engineer to the Chief expert and Head of a Group. Since 2010 to 2016, Dr. Petkov was employed by Scientific Research Center of Sofia University. Since 2017, he is elected to become Assistant Professor in “Atomic Physics” department of Faculty of Physics, where he is currently employed. He speaks fluently English and Russian and also uses Chinese languages. He possesses excellent communicational, organizational, and computing skills.

### **3. General description of the scientific works and the candidate achievements**

Dr. Plamen Petkov has worked and is actively working in two main current scientific fields. The first area is physical chemistry – study of capillary interactions and two-dimensional crystallization of complex fluids. The second area is nuclear energy, where his scientific contributions are related to the modeling of the limiting values of the parameters, determining the safety of nuclear reactors. The contributions are discussed in detail in paragraph 5 of this review. Although at first glance the fields are very diverse, the candidate is founding his activity on general physical laws in processes and phenomena and presents quantitative methods of mathematical physics for computer modeling of specific processes and phenomena. Scientific works, both in quality and quantity, fully meet and exceed the minimum national requirements: article 2b, paragraphs 2 and 3 of the Law for Academic Staff Development in the Republic of Bulgaria and respectively the additional requirements of Sofia University “St. Kliment Ohridski” for holding the academic position of Associate Professor in the professional track 4.1. Physical sciences (General physics). They are undoubtedly the work of the author and there is no evidence of plagiarism. The main additional requirements of the Faculty of Physics for holding the position of Associate Professor are exceeded by all indicators. The scientific papers presented by the candidate do not repeat those of his previous procedures for Assistant Professor and Doctor.

#### **4. Characteristics and estimation of the candidate's academic teaching**

According to the information provided by the Head of the Educational Activities department of Sofia University "St. Kliment Ohridski" for the period 2017-2020, Dr. Plamen Petkov has completed a total teaching of 1244 hours, of which 885 hours are classroom employment. He is a holder of the following 2 full lecture courses in the bachelor's degree: "Nuclear Power Plants" and "Fundamentals of Engineering Design." In the master's degree, he is the holder of the following four full lecture courses: "Thermophysics"; "Reliability in nuclear energy"; "Operational Reactor Physics and Nuclear Safety, Part 1" and "Operational Reactor Physics and Nuclear Safety, Part 2." According to anonymous student surveys, the courses are conducted at a high level and are useful for their overall growth as professionals.

#### **5. Content and analysis of the scientific and scientific-applied achievements of the candidate, presented for participation in the contest**

Before to discuss the scientific achievements, I will describe the scientometrics data of Dr. Plamen Petkov that evidence for his recognition in the scientific environment. The total number of found citations is 132 that define his h-index of five, comprised from the publications submitted in the contest. At the same time his real h-index is six. The five of his publications are cited correspondingly 16,17, 23, 25 and 30 times. At the same time, three of them are in the field of physical chemistry and two of them are in the field of nuclear energetics. This indicates that the candidate published significant scientific publications in both fields. Regarding distribution in quartiles, the publications are distributed as follows: three papers in Q1 (from the presented information in the contest); two papers in Q1 (from his PhD thesis for pending scientific and educational degree "doctor"). At the same time, there is very significant the number of Dr. Plamen Petkov participations at international scientific conferences: 11, as well as participation in six international projects and one national project, related to the topic of the current contest.

The presented information for the contest does not include completely the achievements of Dr. Plamen Petkov in the field of capillary bridges, ordering of colloidal particles on the interphase boundary and the description of two-dimensional pressure of these surfaces. This is a very topical area in the contemporary physics with significant potential application in different scientific areas of science and technology. They evidence for an established scientist with an in-depth approach to the studied processes and phenomena.

Only part of the scientific achievements at the area of capillary bridges (publications 11,12,13,14,15 from Appendix 2) are presented in the competition. The missing part was a subject for the candidate participation in previous contest (for the scientific and educational degree “doctor” and Assistant Professor). Because of this, that part seem cut off from the overall publications set. Capillary bridges (formally, the part three in the presented information) are described by the Laplace equation for the generatrix of interphase surface. Away from the known physical nature its solution up to nowadays is still unknown, because of the strong nonlinearity, ambiguity and bringing the problems to boundary value problems of mathematical physics. In the presented material in the contest, Dr. Plamen Petkov theoretically described the static capillary bridges between two parallel surfaces, where he unconventionally demonstrated the definition domain for their existence: because of the limited volume of the fluid phase at stretching will be always achieved the maximal distance between the surfaces after that the bridge becomes unstable and breaks down. Detailed way is described the behavior of concave and oblate configurations depending on the three-phase contact angle (liquid, gas, solid).

Significant contribution is added by the investigation of the dynamics of capillary bridges at different values of the advancing and receding contact angles. The reliability of the obtained results is evidenced by the careful performed experimental data and the excellent fit with proposed theoretical models. It is not surprising that three of the publications are in journals with impact factor in Q2.

The basic scientific results of Dr. Plamen Petkov in the area of nuclear energetics and reliability of nuclear reactors are covered by the presented materials in the contest (publications 4, 5, 6, 7, 8, 9, 10, 16, 17, 18, 19, 20, 21, 22, 23 in Appendix 2). Of significant interest there are the publications 5, 8 and 9 that possess Q1 quartile. After an analysis of the proposed publications in this area, I classify his scientific achievements in several important topics, according to the specificity of the particular topic and the type of the contributions.

On the first place, I denote the contributions in design and investigation of the safety of small modular fast neutron nuclear reactor (STAR-LM). The obtained results proved the capability of the project to be classified of generation IV nuclear installations. In the contributions are determined STAR-LM specific characteristics during normal operation and natural convection as well as at nuclear accidents. Based on the numerous illustrative modeling cases, developed by the candidate (start-up, shutdown after long term in power operation;

decreasing or increasing the turbine load, loss of heat sink without SCRAM, unprotected overpower transient, etc.) unambiguously is shown the effectiveness of the proposed approaches for optimization and control. The proposed general physical concept is economically substantiated and has a great potential for reactors where the reactivity feedback can maintain: a) the balance between heat generation and heat removal from the reactor core; b) safely shutdown in case of emergency protection failure.

Another type of contributions is related to the statistical uncertainty of controlled parameters and the approaches of statistical analysis of this type of data in the nuclear energetics. These topics have two major difficulties: Firstly, from the significant number of controlled parameters there must be obtained representative sample for the ones, related to the appearance of operational problems. Here, the author combined his practical skills from the work at Kozloduy NPP with his scientific intuition, in order to substantiate his innovative approach for minimization of the obtained database to reliable statistical quantities that are characteristics of a specific physical parameter. Implementation of the Shannon information entropy is used for determination of the reliability boundaries in two dimensional diagrams (contour-plots). Unambiguously has been proven the possibility to be used the entropic approach for analysis of measured controlled parameter and to be compared to the reliable equivalent. By replacement of the deterministic approach with the originally suggestion on the base of Shannon's entropy there is demonstrated unambiguously, the improvement of accuracy which has significant practical application.

Not on the last place are the numerous practical contributions of the statistical approaches for analysis of the physical quantities in nuclear energetics, developed by Dr. Plamen Petkov. I will point only some of them without pretending for comprehensiveness: Developed an approach for controlling the intermediate circuit of main circulation pumps of Kozloduy NPP, where is achieved improved safety and normal operation of the systems. The original analysis of the uncertainties, related to decay heat analysis of nuclear fuel led to revision and updating of the accepted the US Nuclear Regulatory Commission standard RG 3.54. The suggested by the author method for analysis of the effect of irradiation of nuclear fuel on the quantity of the obtained isotopes has a particular importance for determination of the power peaking factor for VVER-440/V230. Even though this design is not any more in usage at Kozloduy NPP, the method is original and has a generalized purpose.

## **6. Critics, comments, and recommendations**

I have no specific critical remarks on the peer-reviewed works. I have the following recommendations for the candidate. Firstly, I believe that it is appropriate for part of the research, related to capillary interactions and the arrangement of colloidal particles in two-dimensional layers, to be completed considering other types of intermolecular interactions. Thus, the scientific contribution in this rapidly developing field of science will acquire a qualitatively new character and can be published in a monograph.

Second, it seems to me that the division of topics on the one hand expands the scope of the candidate's vision, but on the other hand leads to lower scientific productivity. With his election as Associate Professor of physics, it is reasonable to concentrate in one area, in which the candidate will be more productive and will go into depth both nationally and why not globally.

## **7. Personal impressions of the candidate**

I have known Dr. Plamen Petkov for 12 years, and in the period 2010-2016 he worked in our department (Department of Chemical and Pharmaceutical Engineering, Faculty of Chemistry and Pharmacy) on international projects with industrial partners and led a lecture course on "Engineering drawing" and practical exercises and seminars on "Computer Modeling" and "Mechanics of Continuous Media and Rheology". Throughout the work together, the students' responses are excellent: he is a good and demanding lecturer and treats the students carefully. In our joint scientific works, he has shown and still shows a high level of competence, in-depth knowledge of the problems, scientific erudition, original approach, and initiative. It strives to clear even the smallest details and is extremely self-critical and collegial. Demonstrates excellent organizational skills and skillfully distributes and manages project work.

## **8. Conclusion for the application**

After getting familiarized with the materials and scientific works, presented in the contest, 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 the Law for Academic Staff Development in the Republic of Bulgaria (DASRB), Regulations for its application, and the respective Regulations of Sofia University "St. Kliment Ohridski" for taking by the candidate the Associate Professor academic position in the scientific field and the additional requirements in Faculty of Physics. In particular, the candidate meets the

minimum national requirements in the professional track 4.1. Physical Sciences (General Physics). No plagiarism has been discovered in the scientific papers submitted in the contest.

I give my **positive assessment** of the candidate.

## **9. General conclusion**

Based on the above, I **recommend** the scientific jury to propose to the competent authority for the selection of the Faculty of Physics at Sofia University "St. Kliment Ohridski" to elect Assistant Professor Dr. Plamen Veskov Petkov to take the academic position of Associate Professor in the professional track 4.1, Physical sciences (General physics).

4<sup>th</sup> November 2021

Prepared the scientific review by: .....

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