

Review
of a competition for an academic position
"professor"
in professional direction 4.1 Physical Sciences (Physics of atoms and molecules),
for the needs of Sofia University "St. Kliment Ohridski" (SU),
Faculty of Physics, announced in SG no. 24 of 17.03.2023

The review was prepared by Prof. Georgi Lalev Dyankov, PhD, Institute of Optical Materials and Technologies - BAS, in his capacity of a member of the scientific jury, according to Order **RD-38-174 of April, 2023** of the Rector of Sofia University.

Only one candidate has submitted documents to participate in the announced competition: Stanislav Balushev Balushev, associate professor DSc, Faculty of Physics, Sofia University.

I. General description of the submitted materials

1. Application data

The documents submitted by the candidate in the competition correspond to the requirements of the ŽRASRB, PPZRASRB and the Regulations for the terms and conditions for acquiring scientific degrees and occupying academic positions at SU "St. Kliment Ohridski" (PURPNSZADSU).

To participate in the competition, the candidate Stanislav Balushev, associate professor, DSc, submitted a list of a total of 26 papers, including 25 publications in foreign scientific publications and 1 book chapter. A certificate for the supervision of 5 bachelor theses, a certificate for the supervisor of 3 PhD students, dismissed with the right of defense and of one part-time doctoral student who obtained the PhD degree in 2022, certificates of educational employment, a list of selected publications and a list of all publications and patents, list of citations, as well as certificates from the employer. A curriculum vitae, PhD diploma, and MSc diploma are also presented.

The documentation is very well organized, with clear distinctions made for the scientific works involved in the different successive stages of the candidate's scientific career. The documentation presented in this way is credible and convincingly proves that it meets all the requirements for acquiring the academic position of "professor".

2. Details of the applicant

The professional biography of the candidate is impressive. He graduated from the Faculty of Physics at Sofia University in 1990 with honors. He acquired his PhD degree in 1998 and attained his academic rank of Associate Professor in 2009. As a student he specialized in the research department of Lambda Physics in Germany. As a PhD student he specialized for about a year at the Institute of Quantum Optics in Hannover and the Institute of Experimental Physics in Graz. His PhD thesis is in the field of nonlinear optics. All publications related to the PhD thesis are in journals of the First Group (according to the additional requirements of the Faculty of Physics). In the years before attaining the academic rank of Associate Professor the candidate participated in projects as a visiting scientist - in the field of Bose-Einstein condensate (one year in Israel) and in the field of "cooled atoms" (one year in Germany). From 2001 to 2009 he held the prestigious position of a group leader at the Max-Planck Institute for Polymer Research.

The applicant attained the academic rank of Associate Professor on the basis of 16 articles published in prestigious journals, such as *Appl. Phys.*, *Phys. Rev. A*, *Applied Physics Letters*, *Advanced Materials*, etc., all in Group One (according to the additional requirements of Faculty of Physics).

The present DSc dissertation includes papers that were published in the period 2011-2018, as well as patents that were registered in the period 2009-2015. Some of the papers were published when the applicant worked at the Freiburg Institute for Advanced Studies as a Senior Fellow (2014-2015).

In the period 2003-2021 the applicant participated in 9 projects with international and 3 with national funding.

All this shows the dynamic professional growth of the candidate, which has been acknowledged by prominent research centers in Europe and as a result of which he has held prestigious positions. Participation in projects funded by the Max Planck Society, SONY, the Marie Curie Program, the Seventh Framework Program, show the high scientific authority the applicant possesses.

3. General characteristics of the candidate's scientific achievements

The scientific publications included in "Group B indicators" are 4 articles from group 1, category Q1, covering the required minimum score, published in 2021-2022 and in which the candidate has a substantial contribution.

The scientific publications included in "Group D indicators" are 21 articles, of which 15 are from group 1, category Q1, and 6 are category Q2. In seven of the articles, the candidate has a substantial contribution. The articles were published in the period 2012-2022, with 4 of them

published in the last 3 years. The Table. B6 reports the contributions of the co-authors in articles in which Assoc. Prof. Balushev did not make a significant contribution. The same group of indicators also includes a chapter from a book published in 2022. The mentioned scientific publications are estimated at 510 scores, which is more than 2.5 times more than the required minimum.

The scientific publications with which the candidate participates in the competition are systematized in Table. C3. Of these, 7 articles (only one required) are listed as "golden publications".

The candidate meets the additional requirements of the Physics department of Sofia University for teaching experience, as certified by the attached reference from Sofia University.

"Group D" reports 154 citations (presented in Table B4), which corresponds to 308 scores out of the required 100. h - the index of Prof. Balushev is more than 3 times greater than the required one according to the additional requirements of the Physics Department.

"Group E indicators" reports the scientific degree "Doctor of Physical Sciences" awarded to the candidate in 2021, participation in 4 national scientific projects, participation in one international scientific project under the 7th Framework Agreement, leadership of a Bulgarian team in international scientific projects, as well as projects, supported by Bulgarian National Scientific fund, led by the candidate. Under the guidance of Assoc. Prof. Balushev, one student obtained the PhD degree and 5 students defended diploma theses. All this gives the candidate 455 scores out of the required 150.

The analysis made in this way convincingly proves that:

a) the scientific publications meet the minimum national requirements (under Article 2b, Paragraphs 2 and 3 of the RSARB) and, accordingly, the additional requirements of SU "St. Kliment Ohridski" for occupying the academic position of "professor" in the scientific field and professional direction of the competition;

b) the scientific publications presented by the candidate do not repeat those from previous procedures for acquiring DSc and academic positions;

c) there is no evidence of plagiarism in the scientific publications submitted for the competition.

4. Characteristics and assessment of the teaching activity of the candidate

The teaching experience requirement is set at a minimum of 810 hours, which is apparently met according to the teaching employment certificates presented.

5. Content analysis of the scientific and the scientific and applied achievements of the candidate contained in the materials for participation in the competition

The applicant's scientific achievements are in the field of atomic and molecular physics; in particular - on the energy transport in densely populated organic triplet ensembles and on the process of incoherent annihilation up-conversion, as well as in the molecular design and synthesis of environments realizing these phenomena; of the synthesis of dyes enabling optical sensing of physiological parameters.

The hypothesis of fully optical, minimally invasive testing of physiological parameters is formulated. For this purpose, a new family of merocyanine dyes was synthesized, which allows the selective detection of methyl or ethyl alcohol in an aqueous environment. Cationic asymmetric monomeric dyes with halogen-containing substituents have been synthesized. Under certain conditions, the fluorescence intensity was shown to increase by more than two orders of magnitude, showing higher sensitivity in binding to DNK compared to commercially known dyes. Two and three cationic monomethine cyanine dyes were synthesized and found to bind preferentially to double-stranded DNA compared to binding to single-stranded RNA. Newly synthesized tricationic asymmetric cyanine dyes enriched with chlorine-containing cyanine dyes show more than two orders of magnitude more intense fluorescence upon binding to single-stranded RNA.

New styryl dyes were synthesized in which real-time photoisomerization is induced at low excitation intensity, comparable to that of un-concentrated sunlight. Photoisomerization in complexes without rare-earth metal ions, excited with light in the red region and assisted by TTA-UC, was achieved.

The TTA-UC process is central to the candidate's research. A number of sensitizing organic molecules including porphyrins have been synthesized. The energy transfers processes in a densely populated triplet ensemble formed in thin films have been investigated. A palladium-containing porphyrin compound was synthesized. In a synthesized palladium orphyrin-anthracene dyad, an efficient electron transfer between the excited singlet state of the anthracene to the lower singlet state of the porphyrin has been demonstrated. Simultaneously, efficient transfer of the sensitized triplet state to the optically inaccessible triplet state of the anthracene molecule, was observed. In another group of synthesized molecules containing no rare earth metals or noble metal atoms, TTA-UC was demonstrated at room temperature and low excitation intensity, on the order of 100 mW/cm^2 .

A series of substances have been synthesized, allowing the protection of the triplet states from photo-oxidation, which allows obtaining a high quantum yield in a matrix of soft matter. Effective barrier properties of a nanocomposite material based on PMMA/ZnO as well as nanocomposite capsules with a liquid hydrophobic core are demonstrated. The same effect was

shown by synthesized nanoparticles composed of polystyrene coated with organic and inorganic substances. In another type, synthesized nanoparticles are based on natural wax, antibody functionalized and containing optically active molecules protected from oxygen environment.

Prof. Balushev formulated the hypothesis that increasing the temperature of the optically inactive or optically active matrix of soft matter leads to a decrease in viscosity, which ultimately leads to a significant temperature-dependent increase in the intensity of delayed fluorescence, i.e. to a more efficient TTA. The verification of this hypothesis gives rise to the idea of an all-optical measurement of temperature in thin layers. This has been realized in organogels containing an energetically optimized sensitizer/emitter pair. In another organogel based on carnauba wax, a sensitivity better than 100 mK was achieved. For the purpose of intracellular temperature measurement, optically active molecules are housed in nanocontainers with a polymer shell and a rice husk oil core. Penetration of the nanocontainers into the cells of a model cell line showed low cytotoxicity, indicating the promising nature of this model study.

The experimental proof of the hypotheses represents a significant contribution to the field of research. New regularities were discovered and new knowledge was formulated.

Experimental proof of hypotheses demonstrates exceptionally high competence in a complex interdisciplinary field in which the candidate is a leading scientist. The presented scientific achievements represent a combination of fundamental research and their practical implementation. Complete research consistency has been achieved in an interdisciplinary field that demonstrates deep knowledge and extensive experimental experience by the candidate.

The results of DSc Balushev's research have been widely reported by other authors: more than 2,700 citations (without self-citations) have been registered in Web of Science at h-factor 28.

6. Critical notes and recommendations

I have no critical comments on the presented materials on the procedure, as well as on the scientific results.

7. Personal impressions of the applicant

I have mediated impressions of the applicant through colleagues and common acquaintances for the last 15 years. Feedback and comments have always been positive, both in terms of scientific activity and achievements, and as personal qualities.

I have been following the candidate's publications for years and I highly appreciate his scientific activity, aimed at solving significant fundamental problems and striving for practical realizations, solving technological challenges.

8. Conclusion

After getting acquainted with the submitted scientific publications and other materials, and based on 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 on the Development of the Academic Staff in the Republic of Bulgaria and the Regulations for its application and the relevant Regulations of Sofia University "St. Kliment Ohridski" for acquiring the academic position "professor" in the scientific field and professional direction of the competition. In particular, the candidate satisfies the minimum national requirements in the professional field and no plagiarism has been established in the dissertation, synopsis and scientific papers submitted at the competition.

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

II. OVERALL CONCLUSION

Based on the above, I recommend the scientific jury to award to the competent authority for the selection of the Physics department at Sofia University "St. Kliment Ohridski" to elect Associate Professor Stanislav Balushev Balushev to occupy the academic position of "Professor" in professional direction 4.1 Physical Sciences (Physics of atoms and molecules).

13 July, 2023

Review prepared by:

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