

Referee report

for the academic position of "Associate Professor" in professional direction 4.5. Mathematics, specialty "Mathematical modeling and application of mathematics (applications in computational physics and biology)", published in State newspaper no. 21 of 15.03.2022, for the needs of Department "Scientific calculations with Laboratory of 3D digitization and microstructural analysis"

*Reviewer: Prof. Ivan Tomov Dimov -
Institute of Information and Communication Technologies, Bulgarian Academy of Sciences*

The following documents were submitted to the reviewer:

1. Curriculum vitae according to the European model with four appendices;
2. Copy of diploma for the educational and scientific degree "doctor";
3. Certificate of internship in the specialty;
4. List of scientific publications for participation in the competition, which do not repeat those presented for the acquisition of the educational and scientific degree "doctor"
5. List of citations;
6. Summaries of scientific publications for participation in the competition - in Bulgarian and English;
7. Copies of the scientific publications for participation in the competition;
8. Certificate of fulfillment of the minimum requirements of IICT;
9. Reference for the fulfillment of the minimum requirements for registration in the NACID;
10. Reference to the original scientific and scientific-applied contributions;
11. Declaration that no plagiarism in scientific works has been proven according to the law;
12. 8 pcs. electronic carriers with information, according to the requirement of IIKT.

The only candidate in the competition is Dr. Elena Boyanova Lilkova

2. General description of the presented documents

The publications submitted for review are in the area of mathematical and physical modeling of biological macromolecules and complexes. For participation in the competition for the academic position "Associate Professor", a list of 21 scientific publications is attached, of which

19 have already been published and 2 have been accepted for publication. 16 of the already published scientific articles are visible in SCOPUS/Web of Science, of them 4 have an impact factor (two are in quartile Q1 and one each in quartiles Q2 and Q3), the rest have SJR. The two papers accepted for print will be published in a series that also has SJR. 5 of the publications presented for consideration in the competition are not in journals with SJR or impact factor, but have gone through a serious review process by leading European specialists in the field of high-performance software and computing within the international association PRACE (Partnership for Advanced Computing in Europe). The candidate for the competition has presented scientific results in over 40 scientific reports, at international and national congresses, conferences, workshops and seminars. She participated in 16 scientific projects (4 with European and 12 with national funding, of which 11 were funded by the National Institute of Scientific Research and one by the Ministry of Education and Science) and I was the main contractor, resp. head of 2 projects financed under the Program to support the career development of young scientists at the BAS.

The scientific and scientific-applied contributions in the publications submitted for participation in this competition can be divided into the following three categories:

1. Molecular modeling of human interferon gamma
 - 1.1. Structure modeling of hIFN γ
 - 1.2. Mutant forms
 - 1.3. Glycosylation
 - 1.4. Interaction with glycosaminoglycan
2. Modeling of antimicrobial peptides (AMPs)
 - 2.1. Structure
 - 2.2. Behavior and self-organization in solution
 - 2.3. Interaction with membranes
3. Scientific software
 - 3.1. Analysis and testing of specialized applications and packages for high-performance computing;
 - 3.2. Development of tools and methods for molecular modeling of biological systems.

The research, methods, and issues in the individual categories are largely related, overlapping,

and often complementary, and closely related in terms of long-term goals and perspectives.

3. General characteristics of the applicant's activity

3.1. Scientific and scientifically applied activity

The scientific activity of Dr. Elena Lilkova is undoubtedly in the field of mathematical modeling and application of mathematics (applications in computational physics and biology)

3.2. Scientific and scientifically applied contributions

The main contributions of the candidate are in the field of computational mathematics and mathematical modeling with applications in computational physics and biology.

I would like to single out the following achievements in which, in my opinion, the candidate has made serious scientific and scientific-applied contributions:

- A 3D model of the complete cytokine molecule was constructed with the missing amino acid residues from the C-termini added. The solvation energies of various representative conformations of the cytokine molecule were calculated using the free energy perturbation method. The results obtained by Dr. Lilkova determine the compact conformation, in which the C-ends are tucked away next to the cytokine globule, as the most energetically advantageous. To my knowledge, this is the first complete model of the structure of human interferon gamma.
- Studied the structure stability of selected mutants of hIFN γ with substitutions in positions 86-88 (publication D.2). The globule structure stability analysis is based on the multi-step spatiotemporal consensus clustering method. In each molecule, five domains were identified that have specific functions in the molecule, and the effect of mutations on the composition and conformation of these domains was analyzed.
- Metadynamics was used to estimate the probability that the peptides newly isolated in Publication D.8 would embed and pass through an asymmetric model bacterial membrane (see Publication D.12). Based on an analysis of the free energy surface of crossing the lipid bilayer, it was found that for only three of the 10 investigated peptides crossing the membrane from the outer to the inner layer is an energetically advantageous process. In addition, almost all peptides have well-defined deep minima in the hydrophobic layer of the membrane, an indication that they can probably be incorporated into it without translocating.
- A Poisson solver application was developed in the DL_POLY_4 package (publication D.15) as an alternative to the Ewald sum method. The method relies on a combination of the doubly conjugate gradient and conjugate gradient methods to ensure independence of initial conditions as well as stability of the iterative solution. The development of a Poisson equation solver for massively parallel computing on hybrid systems such as the Avitohol supercomputer is

presented in publication D.17. The algorithm is based on a 27-point template discretization scheme and uses a stabilized doubly conjugate gradient.

3. Reflection of the candidate's scientific publications in the literature (known citations)

Dr. Elena Lilkova has documented a total of 36 citations, almost all of which are in specialized publications with SJR or IF rank.

The data presented show that the results of the associate professor candidate are used by professionals working in this important field. Elena Lilkova is an authoritative researcher in the community of specialists dealing with biological macromolecules and complexes and a desirable partner for scientific collaborations.

4. Assessment of the candidate's personal contribution

The candidate's personal contribution is indisputable. All 21 publications presented for the competition are co-authored, but in this field it is natural to work in teams. In all publications, her participation is equal to the other co-authors.

5. Critical notes

I have no critical remarks regarding the results contained in the publications and regarding the design of the contest materials. Based on the impressions I have from various conferences and seminars from Elena Lilkova, I would like to point out that she always treated comments and remarks very seriously and professionally and removed them.

5. Conclusion:

Bearing in mind the above, and the fact that the candidate satisfies all the necessary requirements of ZRASRB, the Rules for the implementation of the ZRASRB, the Rules for the conditions and procedures for acquiring academic degrees and for occupying academic positions in BAS, as well as the Rules for the Specific Conditions for Acquisition of Academic Degrees and Occupation of Academic Positions at the Institute of Information and Communication Technologies at the Bulgarian Academy of Sciences, Dr. Elena Boyanova Lilkova be elected to academic position "Associated Professor" in professional direction 4.5. "Mathematics", specialty "Mathematical modeling and application of mathematics (applications in computational physics and biology)" for the needs of Department "Scientific calculations with Laboratory of 3D digitization and microstructural analysis".

For this reason, my conclusion regarding the occupation of the academic position

"Associate Professor" announced by the competition by Dr. Elena Boyanova Lilkova is
POSITIVE.

07/07/2022

Sofia

НА ОСНОВАНИЕ

331А