REFEREE REPORT

in a competition for the academic position "Associate Professor" in the professional field 4.1. Physical sciences (theoretical and mathematical physics) for the needs of Sofia University "St. Kliment Ohridski "(SU), Faculty of Physics (FzF), announced in State Gazette no. 57 from 26.06.2020 and on the websites of FzF and SU.

I. **General description of the submitted materials**

1. **Submitted documents**

The documents submitted for the competition by the candidate comply with the requirements of ZRASRB, PPZRASRB and the Regulations on the terms and conditions for acquiring scientific degrees and academic positions at Sofia University "St. Kliment Ohridski "(PURPNSZADSU).

For participation in the competition, the candidate Kiril Petrov Hristov submitted a list of a total of 22 titles, including 22. publications in foreign scientific journals with impact factor. The articles are also presented as files, which allows for a detailed acquaintance with them.

15 other documents are also presented, described in detail in the Application of the candidate for admission to the competition and supporting the achievements of the candidate. Among these documents I will note that the applicant has submitted a report showing the implementation of the minimum national requirements for the respective scientific field and the additional requirements of Sofia University.

2. **Details of the candidate**

The candidate was born in March 1985. He received his Bachelor's degree from Jacobs University (Bremen) in 2006. He received his Master degree (with honors) in 2008. at Utrecht University, with this degree he finished also his first publication (№ 1 in the list of his publications, with IF and Q1). He received the degree of Doctor of Philosophy in 2012. at Utrecht University. His dissertation was based on 5 publications (№ 2-6 in the list, all with IF and Q1). He was then Assistant Researcher at the University of Milano-Bicocca in 2012-2015. Since 2015 is working at the INRNE-BAS, first as a physicist, then as an assistant, then as a Chief Assistant. During these years he has also been a lecturer and supervisor of students at the respective universities. It should be especially noted that since 2016 he has been teaching courses in Quantum Field Theory in the master program in theoretical physics at the Faculty of Physics of Sofia University.

He has participated (including with reports) in many international conferences. He has given many reports at seminars in various research centers. He has received many awards for excellent performance during the training for the three degrees. Since working in Bulgaria, he has received

the most prestigious National Pythagorean Award for Young Scientist in 2017, the Marin Drinov Award of BAS for Young Scientist, the annual award for best scientific work at BAS for 2018, the annual award for the best scientific work in INRNE for 2016.

3. **General characteristics of the scientific works and achievements of the candidate**

The scientific activity of the candidate is research. The scientific field consists of modern areas of theoretical and mathematical physics, which meets the specification of the competition.

In general, the scientific field of the candidate is string theory. In particular, his work is on supergravity, which can be considered as a low-energy limit of string theory, as well as a model of quantum gravity. Consideration of supergravity makes it possible to combine supersymmetric theories with classical solutions of gravity, in particular, with solutions of the black hole type. The study of black holes in supergravity and string theory has been intensive in recent years. The fundamental problems of quantum gravity are studied, in particular, applications of black hole thermodynamics in strongly related field theories through the AdS/CFT correspondence.

In addition to the 22 works submitted for the competition, the candidate has 11 other publications. They show that the candidate continues to work successfully in the same field.

Compliance of the scientific works and achievements with the minimum national requirements (under Art. 2b, para. 2 and 3 of ZRASRB) and respectively with the additional requirements of Sofia University "St. Kliment Ohridski" for holding the academic position of Associate Professor in the scientific field of the competition:

The candidate scores the following points: group A: 50 points for the acquired degree doctor; group B (habilitation thesis or equivalent publications): 100 points for 4 papers with IF and Q1 rank - see papers 11-14 from the list of his publications (also Appendix 1); group D (publications other than those in group B): 200 points for 8 papers with IF and Q1 – see papers 15-22 from the list of his publications (also Appendix 1); group E (citations): 262 (required 50) citation points of papers 11-22 (see Appendix 2); Group E (scientific guidance and participation in projects): 65 points.

Thus he scores a total of 677 points - whereas 430 points are required by national requirements.

Also is fulfilled the requirement of FzF points to be collected from the scientific papers submitted by the candidate under № 11-22, which do not repeat papers from previous procedures for acquiring a scientific title and academic position - the latter are under № 1-10.

The other requirements of FzF are also met: Successfully defended a graduate - 1; Number of publications from group I in the last 3 years - there are 5 when a minimum of 1 is required; Number of publications from group I in groups of indicators B and D - there are 12 with a minimum of 7 required; h-factor = 14 at a required minimum of 5

I am not aware of any proven plagiarism in the scientific papers submitted at the competition. Here it should be said that all his works are published in the most renowned international journals and cited in such journals, so the question of plagiarism makes no sense!

4**. Characteristics and evaluation of the candidate's teaching activity**

The candidate was an assistant in three courses in Bremen (in English) - 360 hours, an assistant in Utrecht - 600 hours, a lecturer at the Faculty of Physics in 2016-2020 - 540 hours. Thus, there are a total of 1500 hours with a minimum of 540 hours according to the requirements of FzF.

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

In papers [1,2] the question of string compactification is mainly studied. More precisely, the question of what supersymmetries are preserved and what spaces (moduli) are formed during compactification is investigated. Calabi-Yau space is considered and axial moduli fields of type B_2 and C_2 are found [1]. In [2], maximum supersymmetric configurations in 4-dimensional N = 2 supergravity preserving 8 supercharges were found and analyzed.

In papers [3,4] black holes in gauged supergravity are constructed and investigated. In [3], black holes have the properties of BPS solutions in N = 2 D = 4 supergravity. In [4], black holes have spherical symmetry. It is shown that solutions can be included in N = 8 supergravity and thus in M-theory.

In papers [5,6] are found inequalities that set the BPS limits in D = 4 N = 2 gauged supergravity. In [5] asymptotic anti-de-Siter solutions are considered, and it turns out that there are two unrelated basic BPS states depending on the presence of a magnetic charge. In [6] a more general consideration is made for arbitrary supersymmetric vector and hypermultiplets. The asymptotic charges and masses of black holes are given for different cases of space-time: asymptotically flat, anti de Sitter, magnetic anti de Sitter.

In paper [7] the solutions of nonsupersymmetric static and slow-rotating black holes in an asymptotic flat space are included in a nontrivial way in Abelian gauged 4-dimensional supergravity in the limit of zero scalar potential with nonzero gauge constant.

In paper [8] are studied $N\leq 2$ superconformal and supersymmetric theories on Lorentz 3-dimensional manifolds as preparation to holographic applications and supersymmetric black holes. The preserved symmetries mean the presence of conformal Killing spinors at the boundary. Here a proposal is made for finding the dual superconformal mechanics of magnetic black holes.

In paper [9] we found the thermodynamic properties of a class of spherically symmetric static black holes in 4-dimensional de-Sitter space with magnetic charges and scalar hair. The solutions at zero and non-zero temperatures are considered. The non-trivial case of non-zero temperature

was analyzed in detail. A phase transition of the first kind was found between small and large hairy black holes, which transition is similar to the phase transition between liquid and gas in the dual field theory

In paper [10] new results were found for constructing more general black holes in four-dimensional gauged supergravity. In these theories, black holes are asymptotically anti-Sitter with arbitrary mass, angular momentum, electromagnetic charges, and NUT charge.

In paper [11] is done a systematic search for new solutions and the arrangement of known static solutions in different sectors of the five-dimensional N = 8 supergravity with compact and non-compact groups of R-symmetry.

In paper [12] a connection is made through different dimensions of the supersymmetric horizons of black strings and black holes with different topology in gauged supergravity with nontrivial scalar potential. The obtained lower-dimensional solutions of black holes have amyptotics without maximum supersymmetry. Such solutions are known in the literature, but with the present consideration they receive a new interpretation.

Paper [13] uses a series of Kaluza-Klein and Scherk-Schwartz reductions to connect the supersymmetric horizons and the whole solutions of black holes in a flat space with gauged supergravity with zero scalar potential in 4,5 and 6 dimensions. This allows the consideration of a class of extreme non-supersymmetric black holes in terms of type IIB string theory, keeping 4 supercharges on the event horizon.

Paper [14] presents a method for embedding black string solutions in an asymptotic 5-dimensional anti-Sitter space preserving supersymmetry by adding Wilson loops along a circular direction in space. As a result, a model-independent method was found for adding electric charges to known solutions without breaking the symmetries.

Paper [15] analyzes the horizons of supersymmetric black holes in 4-dimensional gauge supergravity in the presence of multi-derivative terms, including a Weil-square action. As a result, corrections to the Bekenstein-Hawking entropy were found.

In [16,19] it was shown that the Bekenstein-Hawking entropy of a class of supersymmetric rotating black holes in AdS5xS5 [16], AdS7xS4 [19] can be obtained by a simple principle of extremization. The quantity to be extremized strongly resembles Casimir's polynomial of anomalies and supersymmetric energy recently studied for N = 4 supersymmetric Young-Mills.

In paper [17] the Bekenstein-Hawking entropy for a class of supersymmetric black holes in the massive type IIA supergravity background AdS4xS6 was obtained using microscopic counting of the ground states in the dual holographic theory.

In paper [18] the horizons of supersymmetric black holes in 4-dimensional gauged supergravity were analyzed using the supergravity localization technique to calculate the Sen quantum entropy function.

In paper [20] a family of AdS2x$\mathcal{M}$4 supersymmetric solutions was found in 6-dimensional gauged supergravity including an additional vector multiplet resulting from the reduction of massive type IIA supergravity on AdS6xS4. The space $\mathcal{M}$4 can be either a Kähler-Einstein space or the direct product of two Riemann surfaces with metrics with constant curvature.

In paper [21] an explicit supergravity background was found, dual to the Ω-deformation of a 4-dimensional N = 2 superconformal theory on a flat Euclidean space. This solution can be constructed in 5-dimensional N = 4+ gauge supergravity and it has a non-trivial self-dual 2-form.

Paper [22] presents new analytical rotating 4-dimensional amyptotic de Sitter black holes found as solutions of gauge supergravity coupled with Abelian vector multiplets. These configurations retain two supercharges and have a limit to the supersymmetric Kerr-Newman black hole.

Conclusion: All contributions can be classified as receiving and proving new facts. The results definitely enrich the existing knowledge, correspond to modern achievements and represent original contributions to science. The results are widely reflected in the works of other authors - for papers № 11-22 there are 262, totally 677 citations for all his papers according to the page of INSPIRE-HEP!

Most of the candidate's papers are collective: there are 3 papers without co-authors, 4 papers with 1 co-author, 13 papers with 2 co-authors, 1 paper with 3 co-authors, 1 paper with 4 co-authors.

For all papers except № 10 and 20 (which have 3 and 4 co-authors) the candidate evaluates his contribution as significant.

6. **Critical remarks and recommendations**

I have no critical remarks on the scientific nature of the works. I have **insignificant critical remarks** only on the preparation of the materials for the competition. The list of the quotations is presented in a table, arranged by the citation works, and the candidates cited papers appear only with their numbers (from № 11 to №22). Thus, it is not even clear at first glance how many times a particular is cited. Furthermore, the numbers obtained by counting from this table are smaller than those in the over-all list of publications (file 10A). Another negative point is that the required Summary of the original scientific contributions is presented through a table with the abstracts of the papers submitted for the competition.

7. **Personal impressions of the candidate**

I know the candidate since his appointment in INRNE in 2015. He makes a very good impression with the understanding of his scientific activity. He has given many reports at the

QFT seminar. He has been the organizer of this seminar for the last 2 years, and since the pandemic this year he has organized several online seminars on the Zoom platform.

8. **Conclusion on the application**

After getting acquainted with the materials and scientific papers presented in the competition and based on the analysis of their significance and their scientific contributions, I confirm that his **scientific achievements meet the requirements** of ZRASRB, the Regulations for its application and the respective Regulations of Sofia University "St. Kliment Ohridski "for holding the candidate for the academic position Associate Professor " in the scientific field and professional field of the competition. In particular, the candidate satisfies the minimum national requirements in the professional field and no plagiarism has been established in the scientific papers submitted at the competition.

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

II. **OVERALL CONCLUSION**

Based on the above, I **strongly 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 choose Kiril Petrov Hristov to take the academic position of "Associate Professor" in professional field 4.1. Physical sciences (theoretical and mathematical physics) for the needs of the Faculty of Physics at Sofia University "St. Kliment Ohridski ".

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