REPORT

**on a competition for occupying the academic position "Associate Professor"
in the area of higher education 4. Natural Sciences, Mathematics and Informatics,
professional field 4.5. Mathematics, scientific subject
"Equations of Mathematical Physics" (Mathematical Modeling
in the General Theory of Relativity and Quantum Physics)
for the needs of the Institute of Mathematics and Informatics (IMI),
Bulgarian Academy of Sciences (BAS),
announced in State Gazette, Issue 82/27.09.2024 and on the website of IMI, BAS**

The report (opinion) has been written by Tihomir Ilchev Valchev, PhD, Assoc. Professor at the Institute of Mathematics and Informatics, Bulgarian Academy of Sciences, professional field 4.5. Mathematics. I was appointed a member of the scientific jury by order № 435/26.11.2024 of the Director of the Institute of Mathematics and Informatics, Bulgarian Academy of Sciences for the competition.

The **only applicant** who has submitted documents for participation in the announced competition is Dr. Hamed Ahmad Pejhan, Institute of Mathematics and Informatics, Bulgarian Academy of Sciences.

I. General Description of the Submitted Documents

1. Information about the competition documents

The applicant Dr. Hamed Ahmad Pejhan submitted 12 works published in foreign scientific editions for participation in the competition. The following required documents have also been submitted: signed application form for accessing the competition; professional CV; an original and a Bulgarian translation of a Master's diploma; an original PhD diploma and a certificate of recognition of the PhD diploma issued by the IMI, BAS; a complete list of publications; a list of publications for participation in the competition; author's signed statement on the original scientific contributions in the publications for participation in the competition; abstracts of the scientific publications for participation in the competition in English and Bulgarian; copies of the scientific publications for participation in the competition; a complete list of citations; a list of citations for participation in the competition; a copy of the announcement of the competition in State Gazette; certificate for length of service as a postdoc issued by the Zhejiang University of Technology, People's Republic of China and a certificate for length of service as a researcher issued by the IMI, BAS; information about minimal national requirements and the additional requirements of the IMI, BAS; a declaration form (Application 3.2) and a declaration form on storage and processing of personal data.

In addition to all those materials, the applicant submitted a certificate issued by the Islamic Azad University, Tehran, Islamic Republic of Iran, stating that he had been the supervisor of a doctoral student who had successfully defended their PhD thesis.

All the applicant's documents submitted for the competition are in compliance with the Law on the Development of the Academic Staff in the Republic of Bulgaria (LDASRB), the Regulations on the Application of the Law on the Development of the Academic Staff in the Republic of Bulgaria (RALDASRB), and the Regulations at the BAS.

2. Short biographical record of the applicant

Hamed Ahmad Pejhan was born on 21st of March, 1983 in the Islamic Republic of Iran. He completed a Bachelor's degree in Physics at the Urmia University, Iran in 2007 and a Master's degree in Mathematical Physics at the Islamic Azad University in 2010. In 2015, he was awarded a PhD degree in Mathematical Physics by the latter university after defending a dissertation entitled "Krein quantization approach to vacuum energy". The applicant was a postdoctoral fellow at the Islamic Azad University (2015-2018; 2021-2023) and the Zhejiang University of Technology (2018-2021). Currently, he works as a researcher at IMI, BAS. Dr. Pejhan was the supervisor of Surena Rahbardehghan who successfully defended their PhD thesis in Mathematical Physics at the Islamic Azad University in 2018.

The applicant's scientific interests cover the application of group theoretical methods in theoretical physics, more specifically developing a quantum field theory description of elementary physical systems in (anti-) de Sitter space. Currently, Dr. Pejhan is a referee in "International Journal of Modern Physics D" and "International Journal of Theoretical Physics". In 2016, he received the „Distinguished Young Researcher Award" by the Islamic Azad University.

3. General characterization of the applicant's scientific works and achievements

The complete list of Dr. Pejhan's scientific works consists in 23 items: 1 monograph, 17 papers in scientific journals and 5 e-prints. All the works but one have multiple co-authors. The papers are published in peer-reviewed journals with impact factor like "Physical Review D", "Physics Letters B" and "Annals of Physics" just to mention a few. This is a manifestation of a very good scientific productivity.

12 scientific works, published in peer-reviewed scientific journals, have been selected for participation in the competition as follows: 2 papers in "Physics Letters B" (Q1), 5 papers in "Physical Review D" (Q1), 1 paper in "International Journal of Modern Physics A" (Q1), 1 paper in "International Journal of Theoretical Physics" (Q3), 2 papers in "European Physical Journal C" (Q1), 1 paper in "Annals of Physics" (Q1). Information about the minimal national requirements in relation to Art. 26 of the LDASRB and the additional requirements of IMI, BAS for occupying the academic position "Associate Professor" is given in the table below.

Group of indicators	Indicator	Minimal points	Points of the applicant
А	1. PhD thesis	50	50
Б	2. Doctor of Sciences thesis	-	-
В	4. Habilitation thesis – scientific publications, that are indexed and reviewed in world-renowned databases of scientific information	100	130
Г	7. Scientific publications, that are indexed and reviewed in world-renowned databases of scientific information, not included in the habilitation thesis	220	300
Д	11. Citations in scientific publications, monographs, collection volumes, and patents, that are indexed and reviewed in world-renowned databases of scientific information	70	126
Е	13. Supervision of a PhD student who has successfully defended their thesis (50/n points, n stands for the number the PhD student supervisors)	20	50

The points in indicators **В**4 and **Г**7 have been reduced compared to those given by the applicant for the following reasons. First, **the three publications appearing in the indicator B4 coincide with those underlying Dr. Pejhan's PhD thesis hence they should not be taken into account, i. e. the points they carry should be reduced and will not be analyzed further in text.** I have replaced those with the works [1] (Q1), [2] (Q1) and [9] (Q3) from the list of publications submitted for the competition in the indicator **В**4, which originally appeared in the indicator **Г**7. Second, according to RALDASRB **journal quartiles are solely determined from the database "Web of Science" in the case of the professional field 4.5 Mathematics** while the applicant has used the database "Scopus", which is allowed in the case of professional fields 4.1. Physics, 4.2. Chemistry and 4.3. Biology. This leads to certain change in two of the journal quartiles as given by the applicant – "International Journal of Modern Physics A" has a quartile Q1 according to "Web of Science" for the year of publication (2016), while "International Journal of Theoretical Physics" has a quartile Q3 according to "Web of Science" for 2010.

Despite all those remarks, it can be seen that the minimal national requirements in relation to Art. 2b, Par. 2 and Par. 3 of the LDASRB for occupying the academic position "Associate Professor" in the professional field of the competition are fulfilled and even exceeded. After the applicant submitted information and a document in relation to the indicator **Е** that certifies the supervision of a PhD student who successfully defended their dissertation, all the additional requirements of IMI, BAS are fulfilled as well.

No plagiarism has been detected in the scientific works submitted for the competition.

4. Characterization and assessment of the applicant's teaching activity

No information about the applicant's teaching activity has been submitted.

5. Analysis of the applicant's scientific achievements given in the documents submitted for the competition

Thematically the results in the publications submitted for participation in the competition can be classified to the following two groups of topics: covariant quantization of gravitational field in de Sitter space-time (dS) and Krein quantization and vacuum energy problem. All the scientific works selected for the competition have multiple co-authors. Since the applicant has not provided a statement of his personal contributions to those works, I assume that it is equal to that of the other co-authors.

Scientific works [2, 3, 4, 6, 9] from the list of publications selected for the competition belong to the former group of topics. Those works are dedicated to a covariant quantization approach to a massless spin-2 field (graviton) in dS. In the work [9] a conformally invariant equation for a massless spin-2 field in dS and its solutions called by the authors auxiliary fields are studied. A representation of the latter solutions in terms of a massless scalar field as well as a two-point function in the case of a 5D flat space are obtained. In the paper [6] a two-point function of linearized gravitons in dS, which is covariant under the de Sitter group and free of infrared divergences, is derived. Those results are generalized in the publication [4], which contains a group-theoretical approach to the two-point function of linearized gravitons in dS under a two-parameter gauge. A similar gauge of linearized Einstein equations in dS is applied in [3], where the vacuum states of a field of gravitons are studied. It is proved there does not exist a natural vacuum state that is invariant under the de Sitter group. In the work [2] the authors consider a procedure to quantize a free massless spin-2 field in dS, which is covariant under the de Sitter group. Within this procedure no infrared divergences occur and the energy-momentum tensor is nonnegative for physical states.

Works [1, 5, 7, 8] belong to the latter group of topics. In those works a quantization scheme that is based on introducing an indefinite inner product (Krein space structure) is applied to the problem of vacuum energy in dS. This formalism leads to a norm that is positive in the case of physical states, it preserves causality and covariance and it gives rise to a positive energy-momentum tensor. In the publication [8] the vacuum expectation value of the energy-momentum tensor of a conformally-coupled scalar field in dS is studied. In the case of a curved brane with a Dirichlet boundary condition imposed on it the authors obtain the Casimir energy-momentum tensor. In the work [7] the above-mentioned quantization formalism is applied to the problem of black hole radiation in dS. The evaluation of the energy-momentum tensor of a conformally-coupled massless scalar field in the vicinity of a nonrotating black hole demonstrates that it has a black-body radiation in a complete accordance with Hawking's result in the (asymptotically) flat case. In [5] the energy-momentum tensor of a conformally-coupled scalar field in a Friedmann-Robertson-Walker space induced by a Dirichlet boundary condition over curved brane is found. In the publication [1] the authors give an explanation of the small observable value of the cosmological constant based on the Krein–Gupta–Bleuler formalism as applied to dS.

The scientific results contained in the works selected for the competition are purely theoretical in nature. They enrich our knowledge in the area of mathematical physics, more specifically, in the area of quantum field theory in curved spaces which contributes to establishing the quantum theory of gravity. The applicant's results have found good acceptance in the works of other experts – they have been referred to in papers published in renowned journals, e. g. "Physical Review D". This fact demonstrates their significance too.

6. Critical remarks and recommendations

I have no critical remarks to make regarding the setting of problems, the analysis and generalizations, the methodological level, the accuracy and the completeness of the results as well as the acquaintance of existing literature in the publications selected for the competition. However, I have the following two remarks to make regarding the application. First, Dr. Pejhan did not get acquainted well enough with the requirements for occupying the academic position "Associate Professor". For instance, he has selected three papers that are directly connected to his PhD thesis in the list of works for the competition, which is not allowed. Second, the original scientific contributions in the publications submitted for participation in the competition are not stated with sufficient clarity and accuracy by the applicant.

7. Personal impressions of the applicant

I do not personally know the applicant and I have rather limited personal impressions on him.

8. Application conclusion

After getting acquainted with all the documents and the scientific works submitted for the competition and based on the analysis of their significance and the scientific contributions contained in them, I **do confirm** that all scientific achievements fulfill the requirements of the LDASRB, the Regulations on the Application of the LDASRB, and the corresponding Regulations at the BAS for occupying the academic position "Associate Professor" in the area of higher education and the professional field of the competition. No plagiarism has been found in the scientific works submitted for participation in the competition. The application fulfills the minimal national requirements in the professional field of the competition along with the additional minimal requirements of the IMI, BAS which is why I express my **positive** assessment to it.

II. GENERAL CONCLUSION

Taking into account the above stated, I **will confidently join** a decision of the Scientific Jury to propose to the competent body of the Institute of Mathematics and Informatics, Bulgarian Academy of Sciences to elect Dr. Hamed Ahmad Pejhan for the academic position “Associate Professor” in the area of higher education 4. Natural Sciences, Mathematics and Informatics, professional field 4.5. Mathematics, scientific subject “Equations of Mathematical Physics” (Mathematical Modeling in the General Theory of Relativity and Quantum Physics).

Sofia,

14.01.2025 Jury member:

/Assoc. Prof. Tihomir Valchev, PhD/