

## Evaluation report

**on a thesis for the educational and scientific degree PhD  
in professional field of Physical science (4.1),  
on defense procedure at the Faculty of Physics (FzF)  
of Sofia University “St. Kliment Ohridski” (Sofia University)**

**The review is prepared by:** Assoc. prof. Ekaterina Iordanova, Institute of Solid State Physics - BAS, as a member of the scientific jury according to Order No ПД-38-469-23.07.2024 of the Rector of Sofia University

**Topic of the thesis: Extrapolation properties of the Morse-Long Range potential at large internuclear distances**

**Author of the thesis:** Alketa Sinanaj

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

#### **1. Information about the submitted documents**

The candidate Alketa Sinanaj has submitted a Ph.D. thesis titled “Extrapolation Properties of the Morse-Long Range Potential at Large Internuclear Distances,” along with an abstract, and the mandatory tables as per the Regulations for the Acquisition of Academic Degrees and Positions in the Faculty of Physics at Sofia University “St. Kliment Ohridski.” Additional documents have also been provided, including official memos, Appendices 1 and 2, certificates and orders, references, and other evidence of the candidate’s professional accomplishments.

The submitted documents by the candidate meet the requirements of the the requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria and the Regulations for its Regulations, as well as the Regulations on the Conditions and Order for Acquiring Scientific Degrees and Occupying Academic Positions at Sofia University.

#### **2. Details of the applicant**

Alketa Sinanaj was born in 1992 in Elbasan, Albania. After completing her bachelor's degree, she pursued a master’s degree at the University of Tirana, Faculty of Natural Sciences, graduating in 2016 with a specialization in Physics. In 2019, Alketa Sinanaj began her doctoral studies at the Department of Optics and Spectroscopy, Faculty of Physics, Sofia University “St. Kliment Ohridski.” Under the supervision of Prof. DSc. Asen Pashov, she developed a research project on the “Extrapolation Properties of the Morse-Long Range Potential at Large Internuclear Distances.” During her Ph.D. studies, she successfully completed all exams with “very good” grades, including in English, Atomic, and Molecular Spectroscopy. Her professional experience includes extensive teaching practice. She started as a physics teacher in several educational

institutions in Elbasan, Albania, including Medrese “Liria” and the “Imelda Lambertini” school. Since 2016, she has been an Assistant Lecturer at the University “Aleksander Xhuvani,” where she leads seminars and laboratory exercises in physics and related disciplines such as General Physics, Mechanics, Astrophysics, Materials Technology, and Environmental Monitoring. Alketa has actively participated in numerous international conferences and symposia, presenting reports and posters on topics such as spectroscopy and diatomic molecule analysis. Noteworthy contributions include her participation in the BPU11 Congress in Belgrade in 2022 and the 27th High-Resolution Molecular Spectroscopy Conference in Dijon, France, in 2023. Additionally, she has scientific publications, including an article in the Journal of Molecular Spectroscopy, which reflects the topic of her dissertation. Alketa Sinanaj demonstrates a strong academic and professional commitment and motivation for work in the field of physics, particularly in researching energy curves and potential functions of molecules, which is reflected in her scientific contributions and participation in scientific forums and publications.

### **3. General characteristics of the candidate's scientific achievements**

The Ph.D. thesis of Alketa Sinanaj is dedicated to the extrapolation properties of the Morse-Long Range potential at large internuclear distances and makes a significant contribution to the field of molecular physics and spectroscopy. The thesis examines the main theoretical and experimental aspects of the potential energy curves of diatomic molecules, with a particular emphasis on the long-range potential and its application in modeling the physical characteristics of molecules at large internuclear distances. Through her research, the candidate proposes a methodology for estimating the parameters of this potential, which is essential for the fields of quantum chemistry, cold atom physics, and molecular spectroscopy.

#### **Areas of Scientific Research**

The candidate’s research primarily focuses on the following scientific areas:

- **Molecular Spectroscopy and Physics of Diatomic Molecules:** The candidate studies the characteristics of potential energy curves and the extension of the potential at large internuclear distances.
- **Quantum Mechanics of Molecular Systems:** The candidate applies Morse-Long Range potential models to describe complex molecular systems.
- **Cold Atoms and Potential Functions:** The candidate's work is applicable in modeling interactions between cold atoms, which is a current topic in modern physics.

#### **Degree of Compliance with National and Additional Requirements**

##### **a) Compliance with National Minimum Requirements and the Requirements of Sofia University “St. Kliment Ohridski”**

In accordance with the minimum national requirements under Art. 2b, paragraphs 2 and 3 of the Bulgarian Academic Staff Development Act (ZRASRB), the candidate has presented three scientific publications that meet the degree requirements in the relevant scientific field. One of the publications is in a reputable international journal

in Group II (Q3), and the others are in a Group II journal (Q4) and an international specialized journal (SJR 0.115), which meets the necessary level for a doctoral degree. The candidate's dissertation-related publications are cited in the tables in the respective documents, confirming their relevance and contribution to the doctoral degree requirements.

#### **b) Verification of Publication Duplication from Previous Procedures**

The review of the provided tables and accompanying documentation shows that the scientific publications included in the dissertation are not duplicated from previous procedures or requirements for academic positions. The publications and posters presented by the candidate reflect new scientific results and contributions within the dissertation, and none were used in previous procedures for academic ranks or degrees.

#### **c) Plagiarism Check**

In accordance with the academic ethics regulations and the statutory requirements of ZRASRB, the Ph.D. thesis and abstract submitted by Alketa Sinanaj contain no evidence of plagiarism. The absence of proven plagiarism in the submitted materials shows that the candidate's work is independent and reflects her original scientific research and contribution.

### **Conclusion**

Based on the submitted data and documents, Alketa Sinanaj meets all the minimum national and additional requirements for obtaining a doctoral degree in the relevant field. The scientific publications are relevant and sufficient to cover the requirements, show no duplication from previous procedures, and contain no plagiarism.

#### **4. Characterization and evaluation of the candidate's teaching activities**

The candidate Alketa Sinanaj has significant teaching experience, gained across several educational institutions in Albania. She began her teaching career as a physics teacher at the “Nikola Koperniku” school in Elbasan (2016–2017) and subsequently continued as an assistant lecturer at the University in Elbasan from 2016 to 2024. Alketa Sinanaj’s teaching activity demonstrates a strong commitment to academic education and student development. Her experience in teaching a wide range of physics disciplines, including materials science and technology, highlights her excellent preparation and ability to adapt to various aspects of physics and related technologies. The candidate also possesses proven organizational skills in planning and conducting educational sessions, which is an asset in the academic environment.

#### **5. Scientific and scientific-applied achievements**

##### **Scientific Achievements in the Dissertation**

Alketa Sinanaj’s Ph.D. thesis, titled “Extrapolation Properties of the Morse-Long Range Potential at Large Internuclear Distances,” explores a novel approach to analyzing potential energy curves

of diatomic molecules, with a focus on their long-range properties. The work concentrates on expanding knowledge in molecular physics through the analysis and modeling of potential functions that are crucial for understanding interactions in diatomic molecules. The candidate's main achievements include:

1. **Methodological Contribution:** The candidate develops and applies a new method for evaluating the parameters of the Morse-Long Range potential at large internuclear distances, thus providing an important tool for molecular physics and quantum chemistry. This method allows for more accurate estimation of energy levels and spectral lines, making it applicable in spectroscopy and cold atom studies.
2. **Enhancement of Existing Knowledge:** Alketa Sinanaj's work contributes to a deeper understanding of potential functions in the long-range region. The thesis includes a detailed analysis of different approaches to potential modeling, focusing on the Morse-Long Range potential, which demonstrates better extrapolation properties compared to traditional potentials. In this way, the dissertation enriches existing theoretical models, providing better tools for spectroscopic data analysis.
3. **Scientific-Practical Contribution:** The practical aspects of the research are especially relevant for the fields of laser cooling and ultracold atoms, where understanding long-range potentials is critical. The candidate's methodology enables more precise predictions of atomic distances at different energy states and can be applied in modeling molecular interactions under ultracold conditions.

### **Impact of Results on Other Authors' Works**

The candidate has publications in reputable international journals that reflect her scientific achievements and serve as a foundation for future research. Alketa Sinanaj's scientific works include a publication in the *Journal of Molecular Spectroscopy*, which has been cited in other academic studies, demonstrating the recognition of her results in the broader scientific community. Currently, there are several citations of her work, indicating interest and practical application of the methods she has developed.

### **Assessment of Quantitative Indicators**

- **Publications:** The dissertation includes two publications in international journals with an impact factor, which meet the requirements for the educational and scientific degree of "doctor." The publications are in Group II journals (Q3, Q4, and SJR), which complies with the standards of Sofia University.
- **Citations:** Although the candidate is at an early stage in her scientific career, her publications have been cited, highlighting interest in her research from other scholars.

## **Contribution in Collective Publications**

In cases of collaborative publications, the candidate is the main author or co-author with a clearly defined contribution, actively involved in the experimental and theoretical parts of the research. Her specific contribution includes analyzing and applying potential functions for modeling molecular systems, which forms the basis of the presented publications.

## **Conclusion**

The candidate Alketa Sinanaj presents important scientific and applied achievements that significantly contribute to molecular spectroscopy and the modeling of molecular systems. The developed methods and presented results demonstrate originality and substantial contributions to the development of theoretical and applied aspects in the field.

### **6. Critical remarks and recommendations on the submitted works.**

I have no significant critical remarks regarding the dissertation. The only exceptions are some minor technical inaccuracies, which do not affect the value of the dissertation.

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

Do not have.

### **8. Conclusion**

After getting acquainted with the presented dissertation, abstract and other materials, and based on the analysis of their significance, I confirm that the scientific achievements meet the requirements of ZRASRB and the Regulations for its application and the relevant Regulations of Sofia University "Kliment Ohridski" for obtaining the scientific degree "Doctor of Physical Sciences". The candidate satisfies the minimal national requirements in the professional field and no plagiarism has been established in the dissertation, abstract and scientific papers submitted at the competition.

I give my positive assessment of the Thesis.

## **II. OVERALL CONCLUSION**

Based on the above, I **recommend** the scientific jury to award the degree of PhD in the professional field 4.1 Physical Sciences **to Alketa Sinanaj.**

Date: 08.11.2024

Reviewer: Assoc. Prof. Ekaterina Iordanova