

OPINION

on the dissertation

for the acquisition of the educational and scientific degree "doctor"

in professional direction 4.1 Physical Sciences,

by defense procedure at the Faculty of Physics (FzF)

of Sofia University "St. Kliment Ohridski" (SU)

The review was prepared by: Professor, Doctor of Sciences Dimitar Dimitrov Bakalov, Institute for Nuclear Research and Nuclear Energy of the Bulgarian Academy of Sciences, in his capacity as a member of the scientific jury according to Order No. / of the Rector of Sofia University.

Topic of the dissertation: "Investigation of the fine and hyperfine structure of the $c^3\Sigma^+$ state in KRb"

Author of the dissertation: Velizar Rosenov Stoyanov

I General description

1. Overview of the presented documents

The candidate Velizar Rosenov Stoyanov has submitted a dissertation and an Author's abstract, as well as the mandatory documents according to the Regulations for the conditions and procedures for acquiring scientific degrees and holding academic positions at SU "St. Kliment Ohridski" Curriculum vitae, diploma of higher education and its annex, copies of two published works, declaration of authorship, certificate of compliance with the minimum requirements for obtaining the ONS "doctor", and a report on "similarity" of the prevention system available at SU against plagiarism. 4 other documents are also presented, incl. an order for enrollment in regular doctoral studies and an order for extending the term of doctoral studies.

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

2. Applicant data

The applicant was born in 1995; in 2020 he graduated with a master's degree in theoretical and mathematical physics with full honors. He was enrolled in full-time doctoral studies in professional direction 4.1 Physical Sciences, doctoral program "Physics of Atoms and Molecules" at the Department of "Optics and Spectroscopy" in 2020. The doctoral studies were extended until July 2024.

3. General description of the candidate's scientific achievements

- a) The dissertation includes two scientific publications that meet the minimum national requirements according to Art. 2b, para. 2 and 3 of ZRASRB, as well as the additional requirements of SU "St. Kliment Ohridski" for acquiring the educational and scientific degree "doctor". The first of them is in a journal with an impact factor of 2.3 and quartile Q2 according to WoS, and the second is in a journal with SJR=0.18.
- b) The applicant has not participated in previous procedures.
- c) There is no evidence of plagiarism in the submitted dissertation and abstract. The attached 'similarity' report confirms this conclusion.

4. Characterization and evaluation of the candidate's teaching activity

I do not have data on the candidate's teaching activity.

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

The research in the dissertation is in the topical field of laser spectroscopy of diatomic molecules, which allows the comparison of original new experimental data with well-developed theory. The main achievements of the doctoral student are acquisition of new experimental data on the spectrum of the diatomic molecules KRb in a spectral region where the strong spin-orbital coupling of certain states of the potassium and rubidium atoms is manifested, and the extraction of the values of the constants in the effective Hamiltonian of the molecule by fitting the spectroscopic data. The effects of the hyperfine structure of the spectral lines, which in $^{39}\text{K}^{85}\text{Rb}$ lead to profile broadening, while in $^{39}\text{K}^{87}\text{Rb}$ the individual hyperfine components are partly resolved, have been studied in detail.

The substantial contribution of the PhD student to the results published in the article in JQSRT with IF=2.3 can be unambiguously established from the description of the contributions of the co-authors in the article itself. The fact that he is first author and on the article in J. Phys.: Conf. Ser., gives reason to conclude that his contribution is substantial here as well.

The character of the doctoral student's scientific contributions should be characterized as «enrichment of existing knowledge».

The dissertation is structured in 9 chapters. The first two are introductory. Chapter 3 is a comprehensive introduction to the theory of diatomic molecules. In Chapter 4, the "effective Hamiltonian" is defined based on the presentation in the previous Chapter 3. In Chapter 5, the effective Hamiltonian of the KRb molecule is derived and presented in detail. Chapter 6 presents the theoretical foundations of the experimental methods used by the doctoral student. The experiment itself is described in detail in Chapter 7. Data analysis is the subject of Chapter 8. The procedure for deriving the molecular constants by fitting the data is presented in detail - at first by neglecting the hyperfine effects, and at the next stage - by taking them into account. Special attention is given to the discussion of isotopic effects.

The dissertation contains a detailed and well-selected bibliography and is written in good English. The figures successfully complement the text. The tables present the results of the thesis in a convincing and clear way.

Currently, there are no known citations of the doctoral student's articles; in view of their very recent publication, this should not be expected. In addition to journal publications, the results of the dissertation have been presented with poster reports at specialized forums, but unfortunately, no information on these forums is indicated.

6. Critical notes and recommendations

I have no critical remarks on the research approach adopted by the PhD student, nor on the quality, accuracy and completeness of the results obtained by him. In connection with their presentation in the dissertation and the reference to it, however, I will note that there is a lack of clear enough highlighting of the author's contributions. I would like the student to clearly and unambiguously formulate these contributions at the defense of his thesis. It would also be useful to correct some annoying typos in the Bulgarian abstract.

7. Personal impressions of the candidate

I have no personal impressions of the candidate.

8. Conclusion

Having carefully studied the presented dissertation, abstract 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 fully meet the requirements of

ZRASRB and the Regulations for its application and the corresponding Regulations of the SU "St. Kliment Ohridski" for acquiring the educational and scientific degree "doctor". In particular, the candidate satisfies the minimum national requirements in the professional field, and no plagiarism has been found in the dissertation, abstract and scientific works submitted for the competition.

I give my fully positive assessment of the dissertation

II. GENERAL CONCLUSION

Based on the above, I recommend the scientific jury to award the educational and scientific degree "doctor" in professional direction 4.1 Physical sciences to Velizar Rosenov Stoyanov

28.08.2024 Reviewer:

Prof. Dimitar Bakalov, D. Sci.