

## **OPINION**

of the Thesis work

for obtaining the scientific degree "Doctor of Physical Sciences"

in the professional field "Physical Sciences",

under the defense procedure at the Faculty of Physics (FzF)

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

Reviewer: Prof. DSc. Vera Marinova, IOMT-BAS

as a member of the scientific jury according to Order № RD-127/22.01.2021 of the Rector of Sofia University

**Dissertation topic:** "Quantum-optical analogies"

**Author of the dissertation:** Associate Professor Dr. Andon Angelov Rangelov

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

#### 1. Data on the submitted documents

Under the present procedure, the candidate Assoc. Prof. Dr. Andon Rangelov has presented a dissertation Thesis entitled "Quantum-optical analogies" and attached to it Abstract, original papers, as well as a table with a Reference for compliance with the minimum national requirements and the minimum requirements of Physics Department, according to the regulations for acquiring scientific degrees and holding academic positions at Sofia University "St. Kliment Ohridski", Diploma for higher education, Diploma for the educational and scientific degree "Doctor", list of citations to the dissertation, short CV and declaration of authorship.

The presented dissertation consists of 153 pages and is based on 32 publications in peer-reviewed international journals. The illustrative material consists of 62 figures and 8 tables. The list of references includes 163 titles.

The documents submitted by the candidate fully comply with the requirements of the Law on the Protection of Scientific and Technological Research, the Rules of Procedure and the Regulations for the Acquisition of Scientific Degrees and Academic Positions at Sofia University "St. Kliment Ohridski".

#### **2. Details of the candidate**

Assoc. Prof. Dr. Andon Rangelov graduated with honors from the Faculty of Physics at Sofia University "St. Kliment Ohridski", and in 2008 successfully defended his doctoral dissertation on

"Coherent control of quantum systems with pulsed fields". His career continues at the Faculty of Physics of Sofia University as an assistant and chief assistant, and since 2015 is an Associate Professor at the same Faculty of Sofia University.

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

The candidate's scientific results are in the field of quantum optical analogies, polarization optics, nonlinear and wave optics. The presented research in the dissertation-theoretical and experimental is based on analogy between quantum mechanics and classical optics, which makes them extremely relevant and significant for the modern technological requirements for ultrafast devices in telecommunications (where bandwidth is of particular importance), on-chip devices for photonics, in laser technologies, etc.

From this point of view, the topic of the dissertation is highly relevant, and the results of the research presented has significant contribution, both in scientific and scientific-applied aspects.

The Thesis consists of six Chapters and a bibliographic reference, the author's articles of the dissertation are attached as well. The first Chapter is Introduction and focuses on the analogy between the Jones vector of light polarization and the quantum state vector. The aim is to introduce and define arbitrarily accurate broadband wave plates, discussed further in the dissertation. The second Chapter of the dissertation presents a method for making a composite and broadband polarizing rotator, constructed as a sequence of two broadband half wave plates with additional rotation between them. Chapter three is devoted to the adiabatic transformation of the polarization of light and the phenomena of linear and circular birefringence, presenting a polarization transformation analogous to a stimulated Raman adiabatic transition, partial adiabatic transition, and fast adiabatic transition. The fourth Chapter focuses on frequency conversion in a wide frequency range, achieved by using nonlinear photorefractive crystals. Chapter 5 is devoted to the theory and experiments of broadband optical isolators, proposing new optical diodes for applications in polarization and nonlinear optics. The last one, Chapter six, several set-ups for achromatic light separation as well as for light transmission between waveguides (broadband beam splitters) are theoretically proposed and experimentally demonstrated.

From the presented publishing activity in recent years, it is obvious that Dr. Rangelov very actively continues to work on the topic.

The scientific publications included in the dissertation fully satisfy the minimum national requirements (under Art. 2b, para. 2 and 3 of ZRASRB) and respectively the additional requirements of the Faculty of Physics at Sofia University "St. Kliment Ohridski" for acquiring the scientific degree "Doctor of Physical Sciences", in the professional field "Physical Sciences".

The scientific publications included in the dissertation do not repeat those of the procedures of Dr. Rangelov for obtaining the scientific title of "Doctor" and academic position of Associate professor.

There is no proven plagiarism in the dissertation and abstract presented by the author.

#### **4. Characteristics and evaluation of the teaching activity of the candidate**

Assoc. Prof. Dr. Andon Rangelov has an active teaching activity in the following courses: Quantum transitions (Lectures and Practicum for a master's program); Electrodynamics (Lectures and Practicum) and Quantum Mechanics (Practicum). Currently, Assoc. Prof. Dr. Rangelov is a co-supervisor of a doctoral student. He was also co-supervisor of a successful doctoral student and supervisor of three successful Bachelors in Physics.

#### **Analysis of the scientific and scientific-applied achievements of the candidate related to this application.**

Contributions of results, presented in the Thesis can be classified as scientific and applied: theoretical models have been proposed and new broadband devices for changing the optical polarization have been experimentally demonstrated; highly efficient, broadband frequency conversion set-ups have been developed; new optical insulators (a device that allows the light to pass in one direction and almost completely extinguishes it in the opposite direction) have been demonstrated, new optical set-ups for manipulating light in waveguides have been demonstrated as well.

The demonstration of new, broadband devices for changing the optical polarization can be noted as a significant contribution. In addition, highly efficient and broadband frequency conversion set-ups are proposed; new types of optical insulators (optical diodes) as well as new set-ups for manipulating the light in waveguides. The proposed set-ups demonstrate ability to change the elliptical polarization of light by a predetermined value, thus allowing a conversion between linear polarized light to circularly polarized light or to change from left to right circular polarization. The proposed techniques are insensitive to the frequency of light and can serve as achromatic polarization transducers by analogy with the adiabatic techniques in quantum optics.

The dissertation is written on 32 publications in peer-reviewed international journals with impact factor, and according to the criteria they are distributed in Groups of indicators as following: in group of indicators B and D - 30 publications to quartiles Q1 and Q2, group I (with minimum requirements 14); and 2 publications in group III. In group of indicators D - 151 noticed citations are indicated (with the minimum requirements of 100). Most of the publications are in several recognized journals in the field of optics and photonics such as *Opt. Lett.*, *JOSA*, *Phys Rev. A*, *Appl. Opt.* and others. The personal contribution of Assoc. Prof. Dr. Andon Rangelov is obvious - in 17 of them the author has a significant contribution (with a requirement of at least 9). The author has a Hirsch factor of 12 (with a required 6). The total number of points for fulfillment of the minimum national requirements of the candidate is 906. The criteria approved by the Faculty of Physics of Sofia University "St. Kliment Ohridski", are fully implemented.

#### **5. Critical remarks and recommendations**

Short summaries after each chapter or at the end of the dissertation would make it easier for the reader and make the dissertation much more complete. Of course, the above remarks do not detract from the scientific and applied scientific achievements of the author.

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

I do not know Dr. Angelov personally. His scientific activity and publishing activity in extremely renowned journals makes an excellent impression (the total number of the author's articles is 51, of which 32 articles are included in the dissertation). Here I would like to note that the papers published by Assoc. Prof. Rangelov as an author and co-author are professionally written, logically and with innovative ideas, which are undoubtedly highly valued by the optical society. So far, the number of all citations is 575, those in the dissertation are over 150.

Assoc. Prof. Rangelov has an active teaching activity, as well as a management of students and doctoral students. Moreover, I would like to mention the cooperation and long-term publishing activity with world-renowned leaders in the field of nonlinear optics as Prof. Germano Montemezzani, France and Prof. Thomas Halfmann, Germany, which itself is a proof of the candidate's qualities.

## **7. Conclusion**

After reading the presented dissertation, abstract and other materials, and based on the analysis of their significance and contained in them scientific and scientific-applied contributions, I confirm that the scientific achievements of the candidate fully meet the requirements of ZRASRB and Regulations for its application and the relevant Regulations of Sofia University "St. Kliment Ohridski" for obtaining the scientific degree "Doctor of Physical Sciences".

Assoc. Dr. Andon Rangelov satisfies and even exceeds the minimum national requirements in the professional field of "Physical Sciences".

No plagiarism was found in the dissertation, abstract and scientific papers submitted at the competition.

As a conclusion, I give my positive assessment of the dissertation.

## **II. OVERALL CONCLUSION**

Based on the above, I recommend the scientific jury to award the scientific degree "Doctor of Physical Sciences" in the professional field "Physical Sciences" to Assoc. Andon Rangelov



19.04. 2021

Reviewer: Prof. DSc. Vera Marinova