PROFESSOR S.V. KARPEEV IS 60 YEARS OLD

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Abstract. The article presents a summary of scientific and pedagogical activity of a leading researcher of the Institute of Image Processing Systems of Russian Academy of Sciences, Doctor of Physical and Mathematical Sciences, Professor Sergey Vladimirovich Karpeev, a well known expert in the field of computer optics. The celebrant`s contribution to the development of methods of research of diffractive optical elements and the use of computer optics methods to solve a wide range of problems is being analyzed in the article.

Keywords: computer diffractive optics, focusators, compensators, modans, photonic crystals, polarization-mode converters.

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Introduction

In May, 2016 a scientist, a teacher, an expert in the field of research and development of diffractive optical elements, a leading researcher of Image Processing Systems Institute of Russian Academy of Sciences (IPSI RAS), a Professor of Samara nanoengineering Chair of Samara National Research University named after Academician Sergey Korolev, Doctor of Physical and Mathematical Sciences, Professor Sergey Karpeev has celebrated his jubilee.
The article presents a summary of scientific and pedagogical achievements of the celebrant, analyzes the contribution of Sergey Karpeev in the development of computer optics and optical studies.

KuAI-SSAU

In September, 1973 Sergey Karpeev became a student of the newly established Faculty of System Engineering of the Kuibyshev Aviation Institute (from 1992 Kuibyshev Aviation Institute (KuAI) was named Samara State Aerospace University (SSAU), and from 2015 - Samara National Research University). From the second course of his study at the institute Sergey Karpeev began to do research under the guidance of Victor Soifer, who at the time was the first dean of the faculty. That was when Soifer`s research interests have spread to a new and rapidly developing field of digi-

tal holography, which later transformed into a more common one called computer optics. The Institute of Automation and Electrometry (IAE) then became one of the leaders in the new direction of the optical information science. It was in collaboration with researchers from Akademgorodok that the first studies on digital holography were held by the Soifer group. During his study Sergey Karpeev has twice passed practice in the Institute of Automation and Electrometry under the leadership of E. Nezhevenko, he met a young specialist A. Poleshchuk, and their cooperation continues to this day. At that time the USSR industry did not produce laboratory equipment for the coherent-optical research, so the first optomechanics set was made to order at the KuAI experimental plant according to the design made in Novosibirsk. Sergey Karpeev was directly involved in production, combining his studies with work at the Chair of Automated Control Systems (ACS) in the position of research assistant. At this time the first M-6000 and ES computers appear at the institute, which make it possible to produce and explore the first diffractive optical elements (DOE), which at that time were called digital or machine holograms.

Fig. 1. Doctor of Physical and Mathematical Sciences, Professor S.V. Karpeev

After graduating with honors in 1979 by the direction of the Ministry of Higher and Secondary Specialised Education of the RSFSR Sergey Karpeev began working as an engineer. 1980 became the year when the Soifer group began cooperation with an office of the Physical Institute of the USSR Academy of sciences (later GPI AS), which has had a huge impact on the fate of Sergey Karpeev and on the whole group of Soifer in general. Director of GPI was a Nobel Prize winner Academician A.M. Prokhorov, and the locomotive of this cooperation from the GPI side then was the Head of the laboratory of oscillations I.N. Sissakian, a great scientist and a wonderful person, who died already more than 20 years ago. It was then that the first results of cooperation of mathematicians and programmers with physicists- opticians appeared.
Soon emerged an important area of cooperation, which was destined to become one of the breakthrough – focusators of laser radiation. The theme of controlled thermonuclear fusion was then on everyone's lips, and one of the fundamental problems the

scientists were faced with was control of the area shape of focusing laser radiation, acting on plasma. Then once again the gift for foresight of a great man, Academician A.M. Prokhorov, was confirmed, who offered to carry out laser radiation focusing in specified regions of space with the help of computer synthesized elements which were named focusators. First focusator in longitudinal section [1] was made by Karpeev acccording to calculations of M.A. Golub, and was investigated in the visible wavelength range. This teamwork with A.M. Prokhorov, I.N. Sissakian, V. A.Soyfer and M.A.Golub [1] is the most quoted Karpeev`s work today (65 references), and it continues to be actively cited. At the same time another significant trend was born in computer optics, to which Sergey Karpeev switched. V.A. Soifer started to advance the idea of decomposition of the coherent optical fields into orthogonal components using DOE. The idea which at first seemed abstract gained relevance and physical meaning only with the beginning of joint work with GPI. S.G. Krivoshlykov, who worked at that time in the GPI (now a professor in Boston) and was engaged in fiber optics, helped to formulate precisely the task of measuring the spectrum of transverse modes of optical fiber light guides, for which there was no satisfactory solution with the help of devices known at that time. Using the unique properties of DOE which allowed to implement physically what was set only by a mathematical description brought the solution of the problem to another level. In a short time Karpeev managed to implement appropriate spatial filters, called Modans, and to conduct field experiments with optic fiber light guides [2, 3].

All this has helped to create a scientific basis, and in 1983 Karpeev became a correspondence postgraduate in KuAI. His dissertation was planned to be defended in Moscow, in the Council at the GPI on the specialty 01.04.04 "Physical Electronics, including Quantum." According to the Higher Attestation Commission (WAC) regulation at that time only university graduates of physical specialties were allowed to defend their thesis in physical specialties. The rest, including Karpeev, had to pass additional exams in university course of general physics. GPI management regarded this exam and then candidate examination on the specialty very serious, it suffices to say that the examination committee was chaired by N. V.Karlov, the future academician and rector of MIPT. Among the Commission members there also was I.N. Sissakian, Karpeev`s second supervisor, and that further enhances the responsibility. Karpeev has passed both exams successfully, and after that the thesis defense at the most authoritative in this specialty Dissertation Council of the Soviet Union no longer seemed an insurmountable obstacle.

After successfully defending his candidate thesis in 1985 Sergey Karpeev began teaching at KuAI as an assistant of the Department of Technical Cybernetics. It was necessary to introduce a number of new courses for the newly emerging specialization associated with diffractive optics on the faculty. In 1990 Karpeev received the title of associate professor in the Department of Technical Cybernetics, and next 15 years he worked at the department, teaching both subjects for optical information specializations and for future professionals in the field of image processing. He introduced the courses in optical informatics, optical measurement, optical information technologies and systems, optical information processing. Also he was reading courses on information theory, digital signal processing, automated image processing systems, and others.

Karpeev did not leave his science activities. The theme of Modans developed rapidly, there appeared phase [3] and multi-channel Modans. Two Karpeev works were published [4, 5] in top Western journals Optics Communications and Optics & Lasers in Engineering. The paper [5] was one of the first dedicated to practical implementation of Modans. The developed technologies made it possible to move to the actual use of Modans for excitation modes in lightguides (optical fibers) to transmit information [6-19]. An important role was played by Karpeev`s cooperation with German scientists from Jena, which began in the GDR, continuing already in the Federal Republic of Germany. This collaboration has allowed access to the upscale optical equipment, which did not yet exist in Russia. During two month trips to Jena in the framework of the Russian-German project DLR new important experimental results were obtained by Karpeev, which became the basis of joint works [9-12, 18]. The work [4] laid the physical foundations of development of innovative fiber optic sensors in the future [20-22], based on the principles of the mode selection.

IPSI RAS

In 2005, the director of the Institute of Image Processing Systems (IPSI RAS), laureate of the State Prize of Russia in the field of science and technology, V.A. Soifer proposed to transfer Sergey Karpeev to IPSI RAS in order to enhance his scientific research and preparation of his doctoral thesis. The research results obtained in the previous 20 years formed the basis of the monograph written by Karpeev and published by the Radio and Communication publishing house in 2005.

After defending in 2006 his doctoral dissertation Sergey Karpeev did not leave his pedagogical activity and was elected professor of the Department of nanoengineering of SSASU. Already at the new department he published a textbook jointly with S.N. Khonina, based largely on the results obtained in his doctoral thesis.

The work at the new department has expanded the area of Karpeev`s scientific interests and gave him impetus to address such urgent issues as astigmatic modal transformations [23] and the synthesis and study of photonic crystals [24-28]. But the most significant results in this period were obtained by Karpeev in the field of formation of polarization - inhomogeneous beams by methods of diffractive optics [29-39]. It was in this subject that he for the first time was able to publish an article [36] in one of the highly rated magazines Optics Letters (impact factor 3.34). One of the main applications of inhomogeneously polarized beams is sharp focusing, so the study of electromagnetic fields with subwavelength localization by methods of near-field microscopy [40-51] also becomes one of the main Karpeev`s research topics. His publication in Optics Letters [43] has been prepared on this subject.

An important application of DOE becomes their joint use with birefringent crystals [52-59] for forming optical vortices and beams with inhomogeneous polarization.

And finally, new Karpeev works [60-62] are devoted to the important topic of development and testing of space hyperspectrometers. Under Sergey Karpeev`s direction S.V. Alferov has defended his candidate thesis, many students defended their diploma projects and works. Currently under his leadership 2 postgraduate students are working.

Public acceptance

S.V. Karpeev has more than 100 scientific publications, 12 patents, he is the author of the monograph. The article [57], published in the Journal of Optics (impact factor 2.059), was recognized as the best article of the week and included in the review of "Optics in 2015".
The successes of S.V. Karpeev in scientific and pedagogical activity were awarded with:

- a regional premium in Science and Technology in 2008 - the Order of the Governor of the Samara region of 28.04.2009 № 119-p;
- in 2013, the Diploma of the Ministry of Education and Science of the Samara region;
- the title of "Honorary Veteran of Labour of SSAU - a SSAU order, on 23.12.2004.

Conclusion

In conclusion we would like to wish Sergey Karpeev to have strong health, boundless energy, ongoing scientific curiosity, outstanding students, and new creative achievements.

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