FOR THE ANNIVERSARY OF PROFESSOR L.L. DOSKOLOVICH

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Abstract. The article briefly describes the scientific and pedagogical achievements of Professor, Doctor of Physical and Mathematical Sciences, Leonid L. Doskolovich.

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Introduction

In January, 2016 Doctor of Physical and Mathematical Sciences, Head of the laboratory of diffractive optics of the Image Processing Systems Institute — Branch of the Federal Scientific Research Center "Crystallography and Photonics" of Russian Academy of Sciences (IPSI RAS), and professor of the Department of technical cybernetics of Samara national research University named after academician Sergey Korolev, Leonid Leonidovich Doskolovich celebrated his 50th anniversary. The article summarizes the scientific and pedagogical achievements of Leonid Doskolovich.

1 IPSI RAS

In 1989 L. Doskolovich graduated with honors from the Kuibyshev aviation institute majoring in applied mathematics. After graduation, he started working as a software engineer at the Samara branch of the Central Design Bureau of Unique Instrumentation of the USSR Academy of Sciences (CDB UI). In 1993 the Samara branch of CDB UI was transformed into the Image Processing Systems Institute of RAS (IPSI RAS), and in 2016 IPSI RAS became a branch of the Federal Scientific Research Center "Crystallography and Photonics" of Russian Academy of Sciences. Since 1993 L. Doskolovich worked as a researcher, since 1996 – as a senior researcher, since 2002 – as a leading researcher, since 2013 – as a chief researcher, and since 2015 he has been working as the head of the laboratory of diffractive optics of IPSI RAS.

L. Doskolovich`s scientific career developed as follows. In 1993 he defended his thesis "Methods of focusing laser radiation into a system of focal lines", program 01.04.01 “Physics experiment technique, physics of instruments, automation of physical research” at CDB UI of the USSR Academy of Sciences (Moscow), the candidate degree (PhD) of physical and mathematical sciences was awarded to him in 1994. In 2001 he defended his Doctor of Science (DSc) thesis "Calculation of multi-order diffractive optical elements based on nonlinear phase transformation and optimization of the phase microrelief", program 01.04.05 "Optics" at Samara State Aerospace University named after academician S. Korolev (SSAU), the degree of Doctor of physical and mathematical sciences was awarded to him in 2002. The results of his dissertation research were published in the chapters of several monographs edited by V.A. Soifer (corresponding member of RAS) [1-4]. In 2015 for his scientific results in the field of diffractive optics and photonics L. Doskolovich was awarded the title of Professor of RAS.

Currently L. Doskolovich is the author and co-author of 276 scientific papers, including 10 monographs and 9 patents: in the database of RSCI there are 276 his publications and 2620 references (Hirsch index - 24), in the international database Scopus data - 154 Publication and 1117 references (Hirsch index - 18).

2 Samara University

L. Doskolovich combines his scientific activity with teaching. Since 1999 he has been working part-time at the department of technical cybernetics of Samara National Research University named after academician Sergey Korolev (until 2015 - Samara State Aerospace University named after academician S. Korolev (SSAU)). Starting with the position of an assistant and then successively occupying positions of a docent and a professor, in 2009 L. Doskolovich was awarded the title of professor at the Department of Technical Cybernetics. L. Doskolovich gives lectures on probability theory and mathematical statistics, modeling and synthesis of elements of photonics, synthesis of optical systems elements for students studying in the areas of applied mathematics and computer science and applied mathematics and physics. He supervises research work of bachelors, masters, and postgraduate students; he has advised six candidates of physical and mathematical sciences.

Fig. 1. Doctor of Physical and Mathematical Sciences, Professor L.L. Doskolovich

L. Doskolovich has experience of scientific expertise: he is a member of three dissertation committees at SSAU, a reviewer of various foreign scientific journals, an expert of the Russian Science Foundation.

3 The main scientific results

The first scientific results were obtained by L. Doskolovich in the field of calculation of diffractive optical elements (DOEs). This scientific direction was headed by corresponding member of the Russian Academy of Sciences V.A. Soifer, who was the scientific adviser of L. Doskolovich`s candidate (PhD) thesis. DOE are zone plates working in transmission or reflection and having complex boundaries and profile of zones. The working principle of DOEs is based on light diffraction on a thin phase microrelief [1-4]. The DOE design consists in the calculation the boundaries and zone profiles which ensure the desired properties of the optical element. One of the most interesting DOE classes are the so-called focusators of laser radiation. Focusators are DOE that focus laser radiation into thin curves or small areas, calculated in the geometrical optics approximation and having a regular structure of microrelief [1-8]. Focusators enable the formation of the desired spatial profile of laser radiation intensity along a given curve, which determines their wide application in various optical devices. Research in the field of designing the so-called multi-order focusators (the solution of the inverse diffraction problem) formed the basis of L. Doskolovich`s Candidate of Science dissertation. Multi-order focusators are DOEs that allow focusing into a set of curves in different diffraction orders [9-11]. The proposed DOEs combine a diffraction grating, which generates a set of diffraction orders, and a focusator into a line in a single element. Calculation of multi-order DOE is based on nonlinear transformation of the focusator phase function, with the transformation function corresponding to the phase function of a multi-order diffraction grating [12, 13]. A special case of this method is the method of calculating multifocal lenses for focusing into a set of points on the optical axis [1, 14, 15], which later became widely used for calculating multifocal crystalline lenses [16-18]. These studies were continued in Doskolovich`s Doctor of Science dissertation, where he has developed a general analytical method for calculating multi-order focusators intended for focusing into a set of similar or differently shaped curves located in various planes perpendicular to the optical axis. In his dissertation, the method has also been generalized for the task of calculating spectral DOE, designed for separating and focusing radiation of different wavelengths into the areas of identical or different form [19-22]. In this case, DOE calculation was based on a non-linear transformation of DOE phase function according to the law of color separation grating [23]. On the basis of the method of phase nonlinear transformation L. Doskolovich has developed an original method for calculating the quantized DOE, using the approximation of the discrete complex transmission function of a quantized DOE by a truncated series of diffraction orders [24, 25]. The developed method is equivalent by its computational cost to the gradient algorithms for calculating DOE with a continuous phase function. In his dissertation, the iterative methods for calculating multi-order diffraction gratings in the framework of electromagnetic theory were also proposed [26-29]. Later these methods have served as a basis for theoretical studies of extraordinary magneto-optical effects in diffraction gratings comprising a layer of magneto-optical material [30-42]. It has been shown that under resonant conditions the change of the transmission (reflection) coefficient of diffraction grating increases by 3-4 orders of magnitude when the layer material is magnetized, and the angle of rotation of the polarization plane increases by 1-2 orders. The discovered effects form the basis for the creation of new methods of ultrafast modulation of optical radiation by an external magnetic field. The developed theoretical basis for calculation and modeling of diffraction gratings was also used to calculate optical elements designed to steer the propagation of surface electromagnetic waves, in particular, of surface plasmon polaritons [43-56]. This result is of great interest for creating new data processing devices in the on-chip geometry, optical sensors, and near-field nanolithography systems.

Currently Doskolovich`s research interests mainly consist in the development and investigation of new nanophotonic devices for analog optical information processing. Ongoing studies are in line with technologies of silicon nanophotonics, aimed at creating a new generation of computer systems in which the light pulses will be used as information carriers instead of electrical signals. Doskolovich`s works theoretically prove the possibility of analog optical information processing and optical computing on the basis of resonant diffraction structures: diffraction gratings, Bragg multilayer structures, microresonators [57-71]. In the mentioned works, it is shown that these planar diffraction structures enable performing basic operations of spatio-temporal filtering, including spatial and temporal differentiation and integration of optical signals.

For many years, L. Doskolovich actively cooperated with several foreign companies (Fiat, Italy; Targetti, Beghelli and Plast-ottica companies, Italy; LG and Samsung, Korea) in the field of calculation and creation of lighting devices for different applications. The key and most difficult task in this field is to calculate the optical system of the lighting device from the condition of generating a given light intensity distribution. This task belongs to the class of inverse problems of nonimaging optics. Even in the case of only one surface and a point light source, this problem reduces to solving a complex nonlinear partial differential equation of the Monge-Ampere type, and its solution is very challenging. In the works of L. Doskolovich a wide class of methods is developed for solving the inverse problems of nonimaging optics and for calculating lighting devices for different applications [72-87]. The developed methods are widely used for the design of energy-efficient LED-based lighting systems.

Conclusion

In conclusion, I would like to wish Leonid Doskolovich talented students to continue and expand scientific research for development of new devices based on the achievements of diffractive optics and nanophotonics [88-90]!

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