FOR THE ANNIVERSARY OF PROFESSOR S.N. KHONINA

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Abstract. The article briefly describes the scientific and pedagogical achievements of Doctor of Physical and Mathematical Sciences, Prof. Svetlana N. Khonina.

Keywords: Professor, Doctor of Physical and Mathematical Sciences, diffractive optics, singular optics, sharp focus, polarization conversion

Citation: Kolomiets EI. For the anniversary of professor S.N. Khonina. CEUR Workshop Proceedings, 2016; 1638: 207-216. DOI: 10.18287/1613-0073-2016-1638-207-216

Introduction

Recently Doctor of Physical and Mathematical Sciences, chief researcher of the Image Processing Systems Institute of the RAS and part-time professor of Technical Cybernetics Department of Samara National Research University Svetlana Nickolayevna Khonina celebrated her anniversary. The article briefly describes scientific and pedagogical achievements of S.N. Khonina.

1 IPSI RAS

In 1989 S.N. Khonina graduated with honors from the Kuibyshev Aviation Institute on specialty “Applied Mathematics” at the systems engineering faculty. After graduation she started working as an engineer-programmer at the Samara branch of the Central Design Bureau for Unique Instrumentation of the USSR Academy of Sciences, which was transformed in 1993 into the Image Processing Systems Institute of the Russian Academy of Sciences (IPSI RAS). Since 1993 S.N. Khonina was a researcher, since 1994 – a senior researcher, and since 2002 – a leading researcher of the IPSI RAS. In 2015 she took the position of chief researcher of the laboratory of laser measurements of IPSI RAS.

Her scientific career went as follows: in 1995 she defended her candidate thesis on “Optical methods of calculation of uncorrelated features and image structuring”, and in 2001 - a doctoral thesis on “Formation of self-reproducing laser beams by means of diffractive optical elements, matched with the mode composition”, by specialty

01.04.05 "Optics" in the Samara State Aerospace University (SSAU). The results of the thesis research were reflected in the chapters of several monographs edited by Corresponding Member of the Russian Academy of Sciences V.A. Soifer [1-3].
Currently S.N. Khonina has a list of 450 scientific works, including 9 monographs and 4 patents: in the Russian Science Index database - 417 publications and 3407 references (Hirsch index is 27), in the international database Scopus - 235 publications and 1727 references (Hirsch index is 21), in the international database Web of Science - 118 publications and 827 references (Hirsch index is 17).

2 Samara University

S.N. Khonina combines scientific activity with teaching. Since September, 1995 she has been working part-time at the Department of Technical Cybernetics of SSAU. Starting with the position of assistant and then taking successively positions of a docent and a professor, in 2007 she received the title of professor in Technical Cybernetics Department.

Fig. 1. Doctor of Physical and Mathematical Sciences, Professor S.N. Khonina

S.N. Khonina reads lecture courses «Optical computer science» and «Design of the elements of optical systems», conducts practical and laboratory classes for students in directions “Applied Mathematics and Physics”, “Applied Mathematics and Informatics”, leads the research work of bachelors, masters, and postgraduate students, she has prepared four candidates of physical and mathematical sciences, and she is a member of two dissertational councils. During her educational activity she has prepared more than two dozen manuals, and she is a co-author of several monographs [1-3]. S. N. Khonina is the executive performer of network master program "Mathematical methods of modeling and functional design of information systems and optical instruments" which is implemented in cooperation with the St. Petersburg University of Information Technologies, Mechanics and Optics in the frame of the Program of improving the competitiveness of SSAU among the world's leading research and education centers. Since 2014 she has been holding the position of head of the SSAU basic department in IPSI RAS “Optoinformational technologies”.

3 The main scientific results

S.N. Khonina obtained first scientific results under supervising of Prof. V.A. Soifer and under guidance of Prof. V.V. Kotlyar and Prof. M.A. Golub [4-9]. Research on fingerprint recognition [10-12] based on the directions field method formed the basis of her candidate`s thesis. Directions field method allows to extract and convert the information contained in images with structural redundancy (which include fingerprints, interferograms, and other "striped" images) to a more convenient and compact form [13-16]. After such a processing, which may be performed optically, further identification of structurally redundant images is simplified substantially.

The main result of the doctoral thesis of S. Khonina is development of adaptive iterative techniques for calculating the phase diffractive optical elements (DOE) designed to focus the coherent radiation in the plane (or a set of planes and a 3D area) at a predetermined distance with a certain intensity distribution [17-21], as well as to form multimode laser beams with the properties of self- reproduction in different diffraction orders [22-24]. The methods are based on the decomposition of the defined distributions into particular solutions of the Helmholtz equation, such as plane and spherical waves, Gaussian, Bessel, spheroidal and hypergeometric modes, Airy beams, optical vortices [25-32]. Iterative and combined digital holography techniques have been used for phase encoding of DOEs, which were fabricated by electron lithography methods. Experimental testing has confirmed the accuracy of the theoretical results [33-42].

The methods developed for diffraction formation of laser beams with special properties (rotation, periodic reproduction, 3D localization) allowed to extend the functional possibilities of the optical traps [43-47] used for nondestructive capture and manipulation with microparticles.

The multi-channel DOEs matched with different orthogonal basis were applied for solving problems related to measurement of the orbital angular momentum of rotating multimode laser beams [37, 40, 48, 49], mode division multiplexing and selections in optical fibers [50-53], as well as restoring the wavefront using Zernike basis functions [54-57].

One of the problems that S.N. Khonina currently investigates is the diffraction limit overcoming in focusing systems with high numerical aperture. To solve this problem several methods have been developed to optimize the complex transmission function of sharp-focusing system at different polarizations of laser radiation [58-67]. Supplement of the optical focusing system with DOEs allows control the 3D distribution of the intensity in the focal region, to redistribute the components of the electromagnetic field, and to reduce the size of the focal spot.

A remarkable fact was discovered in the course of studies on sharp focusing. It was the possibility to overcome the diffraction limit in the near field zone using the axicons with subwavelength period [68-73]. The generation of the longitudinal component of electromagnetic field on the optical axis in the focal region while entering into the beam with linear and circular polarization of the vortex phase in conditions of sharp focusing was theoretically shown. For the first time the excitation in this case of a strong longitudinal component of the electromagnetic field was theoretically predicted and experimentally confirmed.

To implement best focus conditions it is necessary not only to increase the numerical aperture of the focusing system [71, 74-76], but also to provide a definite combination of polarization and spatial properties of the focused beams. Most existing lasers emit a linearly polarized light, but the most interesting results were found when radiation with radial and azimuthal polarization is focused. Therefore a significant part of S.N. Khonina research is devoted to polarization conversion. Theoretical research was carried out on polarization transformation by using the phase singularities in laser beams (vortex or linear), and also due to the anisotropy of the optical medium in non-paraxial conditions. The efficiency of the DOE for polarization transformation was confirmed experimentally [77-85].

Studies on sharp focusing often led to a comparison of properties of the lens and the axicon. In 2009 S.N. Khonina proposed and theoretically investigated a new diffractive optical element – fracxicon [86], whose phase function is described by a fractional power-law dependence on the radius. Thus, a parabolic lens or an axicon are just special cases of the fracxicon. Variations of the power dependence allow to receive combined properties of several optical elements in one element, that provides control of both longitudinal and transverse distribution of the intensity in the focal region [87-90].

Another object in the field of scientific interests of S.N. Khonina is the study of chromatic properties of DOEs [91-93], which is important both in imaging systems [94-98] and in the laser processing of materials [99-102]. She has considered the influence of the light wavelength deviation from the base one in the manufacture of DOE, as well as the effect of broadening the spectrum while using non-monochromatic radiation sources. I should also note the following areas of her scientific interests [103-108] related with research in the field of diffractive nanophotonics and photovoltaics.

Conclusion

In conclusion, we would like to wish Svetlana Nikolaevna Khonina to get excellent students to continue and expand of scientific research!

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