

**Wave optics in the course of general physics
at Moscow Institute of Physics and Technology**

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ABSTRACT

Place and importance of optics in the system of general education of highest qualification specialists at Moscow Institute of Physics and Technology (MIPT) are discussed.

1.INTRODUCTION

The Moscow Institute of Physics and Technology has a very special place in the system of Soviet higher technical school. It was founded after the second World War at the initiative of a group of the more prominent scientists of the USSR headed by academician P.Kapitza and its aim was to train specialists of a highest qualification in physics and technology.

One of the main principles of what is now generally called "the system of Phystech" is the fundamentality of higher technical education. Its aim is to train wide-scale specialists on the basis of combining fundamental knowledge and purposeful professional training. In this connection of special importance is the perfection of teaching physics to future engineers. The course of physics along with the course of higher mathematics constitutes the essence of the general engineering training and is the basis without which successful activities of the modern engineer are impossible.

The course of general physics at MIPT is taught in the first three years of studies at the institute and takes about 800 hours of the total curriculum. Along with mathematics, it became the basis of the students' general education and is taught on the same program to the students of all future specialists in the field of physics, technology, mathematics, biology and so on. Of particular concern is experimental training (40% of the curriculum). Lectures and seminars are each given 30% of the curriculum. Highly qualified physicists from Moscow scientific-research institutes actively participate in teaching general physics. The educational process has some non-trivial features (the system of tasks aimed at students' independent work, the procedure of passing written and oral exams at the end of each term, the final exam that covers the whole course of general physics at the end of the third year and so on). The education of the students in the field of physics is completed in the course of theoretical physics (about 350 hours of the curriculum).

2. WAVE OPTICS IN GENERAL PHYSICS

One of the most important parts of the course of general physics is optics. It is taken up after mechanics, thermodynamics and molecular physics, and electrodynamics. The foundation of the classical course of optics was laid down by a prominent specialist in this field, academician G. Landsberg. But in the early sixties this course began to lose its self-contained significance, gradually merging with the general theory of waves and oscillations. The revival of optics as an important independent subject turned out to be associated with the advances in science. The inventions of lasers, holography, the development of non-linear optics allowed to bring this course back to life and to modernize it. In its present form this course is based on wave optics which is a wonderful test-field for studying the general wave laws.

In describing the phenomena of interference, diffraction, dispersion, polarization, propagation of waves in anisotropic and non-linear media we try to use an up-to-date approach based on revealing the universal character of oscillatory and wave laws which link optics to other branches of physics, to wave phenomena of a different physical nature (acoustics, radiowaves, etc.).

Special attention is paid to the difference in the scale of wave phenomena whose measure is the wave parameter. The value of this parameter determines the qualitative character of diffraction phenomena and allows to trace the connection between geometric optics and Fraunhofer diffraction. Of considerable importance in the course are the questions of coherence of light: the statistical characteristics of radiation, coherence function, spatial and time coherence, the classical uncertainty principle (the connection between the time of coherence and the spectral linewidth), the influence of coherence on interference phenomena under observation.

The problem of forming optical images, the diffraction theory of optical instruments (telescope, microscope), the theory of spectral devices (grating, Fabry-Perot interferometer), the phenomenon of self-reproduction, the physical basis of optical information processing in our course all this is based on the principles of Fourier optics. We make wide use of such concepts as time and spatial Fourier transformation, spatial filtration. The approach using the ideas of Fourier optics permits to consider the phase problem in optics on the basis of analogies with the well-known radiophysical methods of signal transformation (the reception of the signal without carrier frequency and the dark-field method; the phase shift of carrier frequency and the phase-contrast method; heterodyning in radio and holography in optics).

The principles of optical measurement methods - classical interference methods, holographic and speckle-interferometry are also reflected in our course of wave optics.

Finally, the course of optics includes the consideration of non-linear optical phenomena, frequency doubling, self-focusing, wave front reversal.

It should be stressed again that we speak of optics as a part of the course of general physics. The program presented above requires 15-17 two-hour lectures. The students of the MIPT acquire further knowledge in optics through special courses.

All along the course the students are offered to solve an appreciable number (about 100) of problems on optics on their own. Some of these are just miniature researches in physics and require a profound understanding of the subject. The department of physics of the MIPT has accumulated a good deal of such problems proposed by its professors at various times. Many of them are published in the book "Collected Problems in Physics".

In the course of wave optics special consideration is given to physical experiment. This branch of physics provides the students with ample opportunity to carry out serious physical researches. We have a wide variety of lecture demonstrations that include both traditional experiments (Abbe's classical experiments, experiments on interference and diffraction, etc.) and modern laser demonstrations (optical filtration, self-reproduction, frequency doubling, etc.). The subject matter of each lecture is illustrated by two or three demonstrations.

Lately, we have begun to widely use computers in our lecturing practice, which allows to change and enrich the manner of presentation to a considerable extent. Computer demonstrations furnished with well-organized colour graphics, with the possibility of varying the parameters and conditions of optical experiments yield practically unlimited possibilities that are, unfortunately are not still used to the fully. A series of computer models on wave optics have been developed at our institute. As an example, we may cite the computer program on Fourier optics that allows to illustrate Fresnel and Fraunhofer diffractions, the transition to geometric optics, the phenomenon of self-reproduction, spatial spectra, etc. Besides, the program allows to design optical systems consisting of gratings, lenses, aperture diaphragms, to study the character of diffraction images. Fast Fourier transforms are used for the purpose.

An integral part of the course of wave optics is practical work in the laboratories where each student is given an opportunity to carry out a whole cycle of experiments on optical interference, diffraction, polarization and, besides, on more advanced topics, such as holography, methods of optical filtration, mode composition of laser radiation, etc.

Lectures, seminars and labs compose an integral system under the general physical curriculum. In conclusion, we would like to emphasize the importance of the course of wave optics in preparing the students to a deep understanding of the quantum physical ideas.

Thus, the course of optics at MIPT is an indispensable part of the course of general physics that covers the advances in modern science and has a profound influence on the development of physical outlook of the students.