# Ph. D., Dr. Sc., Prof. Leonid I. Goray

*Strong background in the electromagnetic theory of diffraction and scattering by diffraction gratings, rough mirrors and nanocrystals; Helmholtz equation, Schrodinger equation, non-linear continuum equation, neuromorphic computing, machine learning: 100+ publications, 7 patents*

**Born** November 3, 1963, Nizhniy Novgorod (Gorki in the former USSR).

**Education**

2011 Dr. in Science, Dr. thesis *Analysis of intensity of X-ray scattering on multilayer diffraction elements by an integral equation method* earned in the ***Institute for Analytical Instrumentation*** (***IAI***), ***Russian Academy of Science*** (***RAS***)

2004 Dr. in Physics and Mathematics (Ph.D.), thesis *Numerical analysis of diffraction properties of reflection gratings in X-rays* earned in the ***IAI***, St. Petersburg

1987-1990 Post-Graduated School, ***S.I. Vavilov State Optical Institute***, St. Petersburg. Ph.D. thesis: *The rigorous integral method applied to the calculation of the diffraction efficiency of X-ray and EUV gratings*

1981-1987 The ***St. Petersburg Electrotechnical University (ETU "LETI")***, M.D. (with honors) in *Optoelectronics*

**Job History**

2022-present Principal Researcher, ***ETU "LETI"***

2022-present Principal Researcher, ***University under the IPA of EurAsEC***, St. Peterburg, Russia

2008-present Principal Researcher & Professor, ***Alferov University***, St. Petersburg, Russia

2004-present Principal Researcher, ***IAI***, Russia

1996-present Director and President, ***I. I.G., Inc.***, US-based small private company

Development and distribution of new scientific and engineering software with applications in optics, physics, discrete mathematics and computer science. Development and selling worldwide *PCGrate™ for Windows 16/32/64-bit* software for rigorous efficiency calculations of multilayer diffraction gratings and rough mirrors working from *hard x-ray* to *meter* ranges (more than 500 packages to recognized governmental and military laboratories, private companies, universities and research centers – many of them have several *PCGrate* licenses). Efficiency modeling of flight gratings and Fresnel zone plates for different space missions: the *SOFIA* Airborne Infra-Red Echelle Spectrometer (*AIRES*), the *SKYLAB* spectrograph, the *J-PEX* sounding rocket spectrometer, the Cosmic Origins Spectrograph (*COS*) for the Hubble Space Telescope (*HST*), the Extreme Ultraviolet Imaging Spectrometer (*EIS*) of the Solar-B project (*Hinode*), the Reflection Grating Spectrometer (*RGS*) for the Constellation-X (*IXO*) project, the Solar Imaging Suite (*SIS*) for *GOES-R* satellites, the NASA *Ultra-Stable Extreme Ultraviolet Solar Monitor*, EUV spectroheliographs for the *Kortes* instrument of the International Space Station *(ISS), etc*.
The issue of online *Efficiency Testing Laboratory* (*ETL*) together with ***NASA Goddard Space Flight Center***, ***NRL Space Science Division***, ***Richardson Gratings of Newport Corp.*** and ***Laurence Berkeley National Laboratory*** which is the world's first comprehensive demonstration of the results of grating efficiency tests obtained using modern technologies[1,2].

1993-1997 ***Integrate, Inc.*** Director (since 1993) and physicist-expert in *Theory of Diffraction*.

Design, producing, and exclusive exporting worldwide holographic and ruled diffraction gratings of different types. Development (by the integral and modal methods) and selling through the US company ***Optometrics, Inc***. the software package *PCGrate™ for Windows 16-bit* for rigorous calculation of the efficiency of diffraction gratings with arbitrary groove profiles working from *soft x-ray* to *millimeter* ranges.

1991-1998 ***Holograte, Inc.*** Director, president (since 1991), computer scientist, and physicist in *Theory of Diffraction*.

Development and transfer (to the ***State Institute of Applied Optics*** (***Shvabe***), Kazan) of the new non-organic-based material (chalcogenides) technology for recording of holographic diffraction gratings. Producing and selling holographic diffraction gratings and rainbow holograms of different types.
Idea and creation of the software package *PCGrate™ for DOS* for rigorous calculation of the efficiency of diffraction gratings working from *x-ray* to *microwave* ranges[3], which is based on the modified boundary integral equation method and the personal computing philosophy, in particular, groove profile measurements by Atomic Force Microscopy[4].

1987-1988 ***The State Optical Institute (“S.I. Vavilov GOI”).*** Research scientist on the theoretical investigation of diffraction of electromagnetic waves on relief and phase holograms and gratings.

Development of theoretical approaches for calculations of diffraction efficiency of relief gratings and phase gratings (holograms), i.e., the *Modified boundary integral equation method*[3].

## Awards

1988 The winner of the young scientist work competition, the ***Vavilov State Optical Institute***.
1987 The winner of the master thesis competition, the ***Vavilov State Optical Institute***.

## Membership in Scientific Committees

A member of the Programme Committee and the Editing Committee of IEEE Proceedings of the Annual International Conference “Days on Diffraction”. *http://www.pdmi.ras.ru/~dd/committee.php*

## Reviews and Chapters in English

1. D. L. Voronov, L. I. Goray, T. Warwick, V. V. Yashchuk and H. A. Padmore, "High-order multilayer coated blazed gratings for high resolution soft x-ray spectroscopy," Opt. Express 23(4), 4771–4790 (2015). https://www.osapublishing.org/oe/abstract.cfm?uri=oe-23-4-4771
2. L. I. Goray, T. N. Berezovskaya, D. V. Mokhov, *et al.*, “Fabrication and Soft-X-Ray and EUV Range Testing of Au- and Multilayer Mo/Si-Coated Diffraction Gratings with High-Order Blaze,” Bulletin of the Lebedev Physics Institute, 2023, Vol. 50, Suppl. 2, pp. S251–S262. DOI: 10.3103/S1068335623140063
3. L.I. Goray and G. Schmidt, “Boundary Integral Equation Methods for Conical Diffraction and Short Waves,” in *Gratings: Theory and Numerical Applications*; ed. E. Popov. 2nd rev. ed. (Institut Fresnel, AMU, 2014), Ch. 12. ISBN 2-85399-943-4. http://www.fresnel.fr/numerical-grating-book-2
4. Leonid I. Goray, ‘Diffraction Grating Groove Metrology Using AFM & STM’, in *Recent Developments in Atomic Force Microscopy and Raman Spectroscopy for Materials Characterization*, ed. C. Pathak & S. Kumar (IntechOpen 2022). ISBN 978-1-83968-230-8. https://www.intechopen.com/chapters/76394