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

Strong background in the electromagnetic theory of diffraction and scattering by diffraction gratings, rough mirrors and nanocrystals: 100+ publications, 5 patents

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

Education

2011 Dr. in Science, 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***) of the ***Russian Academy of Science*** (***RAS***).

2004 Dr. in *Physics and Mathematics*, thesis *Numerical analysis of diffraction properties of reflection gratings in X-rays* earned in the ***Institute for Analytical Instrumentation*** (***IAI***) of ***RAS***.

1987-1990 Post-Graduated School of the ***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***, M.S. (with honours) in *Optoelectronics.*

Job History

2008-present Principal Researcher, St Petersburg Academic University, ***RAS***.

2004- present Principal Researcher, Institute of Analytical Instrumentation, ***RAS***.

2016-present Advanced Engineer, ITMO University, Russia

1996- present The US company ***I. I.G., Inc.*** Director and President.

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 400 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* for the Hubble Space Telescope, 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 for *GOES-R* satellites, the NASA *Ultra-*

Stable Extreme Ultraviolet Solar Monitor, EUV spectroheliographs for the *Kortes* instrument of the International Space Station, *etc*.
The issue of online *Efficiency Testing Laboratory* (*ETL*) together with ***NASA Goddard Space Flight Center***, ***NRL Space Science Division***, and ***Richardson Gratings of Newport Corp.***, which is the world's first comprehensive demonstration of the results of grating efficiency tests obtained using modern technologies.

1993-1997 ***Integrate, Inc.*** Director and physicist 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 1993), computer scientist, and physicist in *Theory of Diffraction*.

Development of the new non-organic-based material 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 *VUV* to *microwave* ranges, which is based on the developed modified integral method and the personal computing philosophy.

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, i.e. the boundary integral equation method.

Awards

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

1987 The winner of the master thesis competition, ***Vavilov State Optical Institute***.

Membership in Scientific Committees

Member of the Scientific Organizing Committee and the Editing Committee of IEEE Proceedings of the annual International Conference "Days on Diffraction".

List of Publications in English

1. L.I. Goray, "Aberrations of concave diffraction gratings produced by flexure of crystals," *Optics and Spectr.*, vol. 61, # 3, pp. 628–630, 1986.
2. L.I. Goray, "Diffraction efficiency of high aperture ratio concave gratings with constant groove profiles along the aperture," in the All-Union Seminar *Holographic optical elements and their using in industry*, Moscow, abstracts, p. 55, 1987 (in Russian).
3. L.I. Goray, "Aberrations of concave strained crystal diffraction gratings with initially curvilinear and non-equidistant grooves," *Optics and Spectr.*, vol. 65, # 1, pp. 184–187, 1988.
4. L.I. Goray, "Method of manufacturing of an aspherical surface," *SU inventors certificate* # 1453251, 09.15.1988, MKI^4 G 02 B 5/18.
5. L.I. Goray and L.A. Dmitrieva, "Brewster anomalies in zero order of deep dielectric gratings," in the All-Union VI Conference of Young Scientists on *Optics and Holography*, Leningrad, abstracts, p. 7, 1988 (in Russian).
6. L.I. Goray, "Method of manufacturing of a concave diffraction grating," *SU inventors certificate* # 1510562, 05.22.1989, MKI^4 G 02 B 5/18.
7. L.I. Goray and G.M. Savitzky, "Holographic relief gratings for X-ray optics," in the All-Union Seminar *Questions of Applied Holography*, Tbilisi, abstracts, p. 20, 1989 (in Russian).
8. L.I. Goray and G.M. Savitzky, "Diffraction properties of blazed gratings for X-rays," in the All-Union X Symposium *Diffraction and Propagation of Waves*, Vinnitza, abstracts, pp. __, 1990 (in Russian).
9. L.I. Goray, B.A. Matveev, N.M. Stus, G.N. Talalakin, and S.G. Yastrebov, "Method of manufacturing of a concave diffraction grating," *SU inventors certificate* #1514120, 06.08.1989, MKI^4 G 02 B 5/18.
10. I.Y. Yusupov., M.D. Mikhailov, R.R. Herke, L.I. Goray, S.B Mamedov, O.A. Yakovuk, "Investigation of the arsenic sulphide films for relief-phase holograms", in *Three-Dimensional Holography: Science, Culture, Education*, T.H. Jeong and V.B. Markov, eds., SPIE Proc., vol. 1238, pp. 240–247, 1989.
11. L.I. Goray and G.M. Savitzky, "Diffraction properties of laminar gratings for X-rays" in the All-Union VI Conference on *Holography*, Vitebsk, abstracts, p. 33, 1990 (in Russian).
12. L.I. Goray, B.A. Matveev, and S.G. Yastrebov, "Method of manufacturing of a concave diffraction grating," *SU inventors certificate* #1568774, 02.01.1990, MKI^4 G 02 B 5/18.
13. L.I. Goray and G.M. Savitzky, "Diffraction properties of high frequency X-ray gratings," in the All-Union VI Seminar *Diffraction Optics. New Developments in Technology and Applications*, Kazan, ext. abstracts, pp. 66–67, 1991 (in Russian).
14. L.I. Goray, "Numerical analysis for relief gratings working in the soft X-ray and XUV region by the integral equation method," in *X-Ray and UV Detectors*, R. B. Hoover and M. W. Tate, eds., SPIE Proc., vol. 2278, pp. 168–172, 1994.
15. L.I. Goray, "Non-scalar properties of high groove frequency gratings for soft X-ray and XUV regions: the integral equation method," in *X-Ray and UV Detectors*, R. B. Hoover and M. W. Tate, eds., SPIE Proc., vol. 2278, pp. 173–177, 1994.
16. L.I. Goray and B.C. Chernov, "Comparison of rigorous methods for X-ray and XUV grating diffraction analysis," in *X-Ray and Extreme Ultraviolet Optics*, R. B. Hoover and A. B. Walker, eds., SPIE Proc., vol. 2515, pp. 240–245, 1995.
17. L.I. Goray, "Rigorous integral method in application to computing diffraction on relief gratings working in wavelength range from microwaves to X-ray," in *Application and Theory*

of Periodic Structures, T. Jannson and N. C. Gallagher, eds., SPIE Proc., vol. 2532, pp. 427–433 (1995).
18. M.P.Kowalski, J.F.Seely, L.I.Goray, W.R.Hunter, and J.C.Rife, "Comparison of the calculated and the measured efficiencies of a normal-incidence grating in the 125-225-Å wavelength range," *Appl. Opt.*, vol. 36, # 34, pp. 8939–8943, 1997.
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21. L.I. Goray, "Modified integral method for weak convergence problems of light scattering on relief grating," in *Diffractive and Holographic Technologies for Integrated Photonic Systems*, R. I. Sutherland, D. W. Prather, and I. Cindrich, eds., SPIE Proc. , vol. 4291, pp.1–12, 2001.
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24. L.I. Goray and J.F. Seely, "Efficiencies of master, replica, and multilayer gratings for the soft x-ray–EUV range: modeling based on the modified integral method and comparisons to measurements," *Appl. Opt.*, vol. 41, # 7, pp.1434–1445, 2002.
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26. L.I. Goray and S.Yu. Sadov, "Numerical modelling of coated gratings in sensitive cases," *OSA TOPS*, vol.75, pp. 365–379, 2002.
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grazing incidence off-plane grating in the soft x-ray region," *Appl. Opt.*, vol. 45, #8, 2006, pp. 1680–1687.

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51. L.I. Goray, J.F. Seely, "Grazing incidence off-plane lamellar grating as a beam splitter for a 1-Å free electron laser," in the Symposium *Nanophysics and Nanoelectronics*, Proc. of Institute for Physics of Microstructures, RAS, Nizhniy Novgorod, pp. 337–338, 2007 (in Russian).
52. L.I. Goray "A rigorous solution for electromagnetic scattering from multilayer structures having asperities of any kind in X-ray–EUV ranges, SPIE Proc., pp. 661719-1-12, 2007.
53. L.I. Goray, G.E. Cirlin, E. Alves, Yu.B. Samsonenko, A.A. Tonkih, N.K. Polyakov, V.A. Egorov, "Determination of the structural properties of multiple quantum dot ensembles based on a rigorous X-ray specular and diffuse scattering analysis and comparison with measurements," Proc. of Nanostructures: Physics and Technology, pp. 118-119, 2007.
54. L.I. Goray, "A rigorous method for random roughness accounting in X-ray–VUV ranges," in the 9-th International Conference *Physics of X-Ray Multilayer Structures*, Big Sky Resort, Montana, U.S.A., abstract P2.2, 2008, http://www.rxollc.com/pxrms/abstracts/Goray.pdf .
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56. L.I. Goray, "A boundary integral equation method in short-wavelength-to-period diffraction on 2D gratings and rough mirrors," Abstracts of the Int. Conf. "Days on Diffraction", St. Petersburg, Russia, p. 14, 2008.
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