Optics in Switzerland, Part 3: Industries and Observatories

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"The nature has shown itself lavish in its bestowal towards Switzerland.... Where else to find on the earth such amalgam of mountains and of meadows, of lakes and of woods? Nowhere contains in as much relatively limited space such concentration of greenery, water, trees, mountains, snow and glaciers mixed up in as delicious manner."
André Gide, 1912

The most striking thing about optics in recent years has been the sweep of its reach. It has spread into many areas of innovative research and development in basic and applied sciences, engineering, and industry. The results presented in the papers published in the trilogy "Optics in Switzerland" (parts 1 and 2 appeared in the July and August issues) are a testimony to this rapid evolution in optics that has been relentlessly at work over the last many years.

The final section in the trilogy "Optics in Switzerland" is devoted to optics in Swiss industries and observatories. This special section provides an awareness of the kind of relationship that exists between academics and industry. A goal of the section is to inspire, expand, and strengthen the exchanges and cooperation between the two. The 20 papers in this special section draw upon knowledge and expertise in different areas of optics. A brief survey of optics-related research and development being pursued in Swiss industries and observatories follows.

Optics in Swiss Industries

ABB Corporate Research in Baden is investigating and developing fiber optic sensors for the electric power industry. Major efforts are devoted to the development of optical current and voltage sensors. The optical voltage sensors are based on the piezoelectric effect in quartz or the electro-optic effect in a BGO crystal. The optical current sensor uses the Faraday effect in bulk fused silica or a silica glass fiber coil. Both interferometric and polarimetric detection schemes are used. Field tests have shown promising results.

The Microtechnology section of AGIE Ltd. in Losone is involved in the research, development, and production of miniature optical sensors with an emphasis on a new family of optical sensors intended for precision positioning of small objects in automatic microassembling operations. The areas of expertise include fiber optic sensor technology, micro-optics, miniaturization, optoelectronics, and precision micromachining.

Ascom Tech, the corporate research division of Ascom, is involved in different research areas of telecommunication systems. System concepts and technology for broadband communications are the major part of their activities. These include high-speed optical fiber networks and optics in the local loop. Concepts are demonstrated by the realization of test beds such as the very high speed optical loop, fiber optic access networks, and photonic switching in general. Advanced optoelectronic packaging technology activities are also of major interest. The packaging group produces long-term, stable, submicron-accuracy optical connections between optoelectronic components and single-mode fibers using laser welding fixing technology. Ascom Tech is involved in several research projects related to optical communication and networks, e.g., the ATMOS project, which aims at demonstrating 2.5 Gb/s high-capacity switching systems needed for asynchronous transfer mode based broadband networks, and the broadband access facilities project, which provides guidelines for technical and economical applicability of broadband access facilities.

Bystronic Laser Ltd. in Niederönz is a manufacturer of laser processing systems, mainly for sheet metal cutting. High-power CO_2 lasers of up to 2800 W as well as computer numerical controlled (CNC) machines and programming software are developed in-house. The CNC machines incorporate features such as means for material handling, the exchange table system, and flying optics. Another area of expertise is in the laser cutting and laser welding of round and profiled tubes.

Cabloptic in Cortaillod is dedicated to the production of telecommunication-grade silica optical fibers. Its research mainly involves projects to continously increase the production capacity, the production yield, and the fiber quality; projects dealing with special fibers and fiber-based devices; and the development of mechanical devices for manual and automatic alignment of fibers to ribbons for optical time domain reflectometry systems.

Cerberus Ltd. in Maennedorf is a manufacturer of fire and intrusion detection systems. Its activities in optics are focused on the design and development of optical systems for light scattering and light extinction fire detectors, and for passive infrared intrusion detectors.

Important optics-related research and application activities are currently in progress at Ciba-Geigy's Marly- and Basel-based research centers. In Marly, these activities primarily concern laser photopolymerization, in particular, stereolithography; laser-based methods (holographic cure monitoring, interferometric shrinkage monitoring, and fast photocalorimetry) in the study of polymerization kinetics; investigation of photopolymer molding techniques for manufacturing using high-power UV light sources; and development and testing of active layers for optical data storage. The work on optics at Basel includes optical spectroscopy, laser fluorescence, radiometry, light scattering, ellipsometry, microscopy, and fiber optics.

The Swiss Center for Electronics and Microtechnology in Neuchatel is a private company held by leading Swiss companies and organizations. Advanced research programs and related infrastructure are supported by the Swiss federal government. The strategic technical fields are low-power integrated circuits and systems; microsystems and subsystems; and biological inspired systems. The activities range from applied research to product development. It has developed expertise in the areas of high-resolution lithographic techniques, diffractive optical elements, optical sensors, technology and applications of special optical fibers, and thin films. System engineering of optomechanical systems is also offered for aerospace projects.

Fisba Optik in Saint Gallen specializes in the design and manufacture of micro to large optical systems of different complexities over the complete optical spectrum from 0.2 to 20 μm. Its main research and development directions are diode lasers, laser optics, micro-optics, and interferometers.

Gretag Ltd. in Regensdorf develops and produces color photofinishing equipment, color control systems, and large screen TV projectors. All Gretag products contain different kinds of optics (illumination optics, imaging optics, fiber optics, diffraction optics, micro-optics, dichroics, and optical light valves), which are mainly designed within their own facilities. The company is also working on enhanced definition and on simpler and easier ways to operate their Eidophor projectors.

At Hoffmann-La Roche in Basel, research in optical bioanalytics concerns the development of a highly sensitive optical transducer to detect the interactions between biomolecules in real time using a sensor chip with a chemically modified surface. This novel analytical technique is applicable for the functional characterization of macromolecules in biological assays.

Holotronic Technologies Ltd. in Marin develops microlithography systems based on a holographic technique. Its systems are now gaining acceptance in the microelectronics industry, especially for the manufacture of flat panel displays.

Lasag Ltd. in Thun manufacuters pulsed Nd:YAG lasers for welding, cutting, and drilling. It belongs to the SMH Holding of Swiss watches, including brand names such as Swatch, Omega, and Tissot. Lasag's expertise covers the development and production of pulsed Nd:YAG laser sources, beam delivery, and applications.

At Telecom PTT, work in optics concerns mainly those topics that support optimal network and service performance. This includes all aspects of optical transmission over fibers. Other activities include the near-field measurements for optical fibers and aspects of optical nonlinearities in high-speed transmission systems. Research contracts with the universities and research institutes broaden the base for network and service optimization. Telecom PTT is active in international standardization bodies such as ETSI and ITU. An optical calibration service has been established to guarantee optimal precision of laboratory and field measurements.

Projectina Ltd. in Heerbrugg, founded in 1946, develops and manufactures inspection and measuring equipment for industry. In the beginning, the company mainly concentrated on the design and production of projection microscopes, then in 1968 it extended its expertise to include services in the technical disciplines of optics, optoelectronics, and high-precision mechanics. The company produces stereo and video microscopes and inspection systems for checking printed circuit boards, and develops products for forsenic science laboratories for document analysis (detection of forged documents and bank notes, comparison of fingerprints, tool marks, etc.) and identification of narcotics by FTNIR spectroscopy. It also designs special light sources and filters for the detection of fingerprints.

The Robert Bosch Institute of Research in Lonay performs research and development in optics, precision mechanics, and signal processing. Its main optics-related activities concern the calculation and simulation of car headlights, calculation and realization of zoom lenses, application of glass and plastic fibers, and the development of components for road and traffic guidance systems.

Optics in Observatories

The Physikalisch-Meteorologisches Observatorium Davos, as a World Radiation Centre, is responsible for the worldwide homogeneity of solar radiation measurements. The basis for these measurements is the world radiometric reference maintained at Davos by the World Standard Group. These measurements are performed by electrically calibrated cavity instruments. Similar radiometers are developed for measurements of the total solar irradiance outside the atmosphere from stratospheric balloons, sounding rockets, and satellites. Sunphotometers (SPM), which are interference-filter-silicon-diode instruments, are used for the spectral measurements of direct solar irradiance. Highly stable SPMs are developed to measure both the solar spectral irradiance from space and the spectral extinction and optical depth from the ground. Pyranometers and pyrgeometers are used in the accurate measurement of the surface radiation budget.

The main goal of observational astronomy performed at the Geneva Observatory is the galactic structure. Observations are carried out both on internationally operated and locally developed telescopes. Two new alt-azimuth 1.2-m telescopes are in the final phase of construction at the observatory for the northern and southern hemispheres. A seven-color photometric system defined at the observatory gives precise informa-

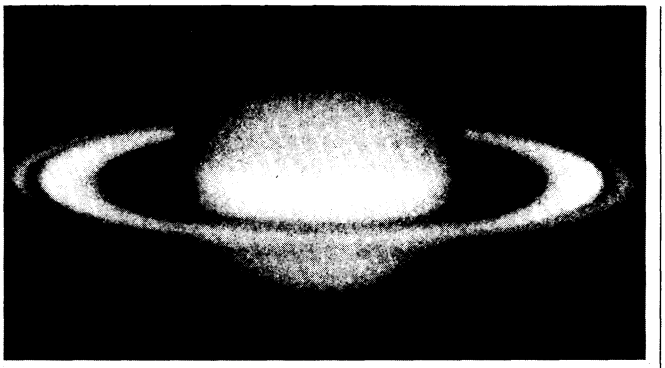


Image of Saturn taken with a 40-cm telescope from the south tower of the Gornergrat observatory [P. Guérin, Obs. de Paris, in Winneweisser et al., 20 ans d'astronomie au Gornergrat télescopes radio-et infrarouge, Orion **226,** 96–107 (1988)].

tion on the temperature, chemical composition, evolution, and variability of stars. The Geneva photometric catalog provides a unique, homogeneous set of 300,000 measurements of 40,000 stars. Single- and two-channel photometers, and more recently CCD imaging, have allowed photometric precision of 0.1 to 0.2%, stable over more than 35 years. The observatories in Geneva and Marseille collaborated to construct two radial velocity correlation spectrometers, one in Haute-Provence, France, and one in ESO-La Silla, Chile, which have been in operation since 1977. The stellar radial velocity is measured with a precision of 0.2 km/s. The collaboration has led to the development of two new stellar velocimeters (the first in operation since 1993), pushing the limit on precision to 10 m/s. Another direction of activity is toward the development of optically stabilized platforms for stratospheric balloons capable of pointing a 150-kg scientific payload at the sun, stars, and planets with a stability of a few arcseconds from an altitude of 40 kms. Six instruments are presently flying on these gondolas: a 40-cm UV imaging telescope, a 60-cm far-IR telescope, a high-precision solar bolometer, and three atmospheric spectrometers for the detection of stratospheric trace species.

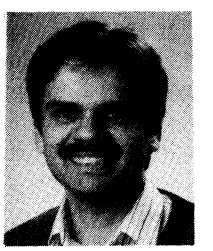
Since 1967, the Gornergrat astronomical station has hosted two telecopes for astrophysical observations. Its location in the Swiss Alps at an altitude of 3135 m provides superb quality in terms of atmospheric transparency in the infrared and for the submillimeter to millimeter spectral range. The north tower of the observatory hosts TIRGO, a 1.5-m infrared telescope operated by the Italian Center for Infrared Astronomy and the Study of the Interstellar Medium. The south tower of the observatory hosts KOSMA, the 3-m radio telescope operated by the University of Cologne. The two instruments are mainly dedicated to the study of the interstellar dust and molecular clouds and associated star formation regions. Whereas the 1.5-m telescope is primarily suitable for observing the dust distribution in the infrared, the 3-m radio telescope explores the large-scale distribution, structure, and dynamics of molecular clouds by observing molecular and atomic spectral lines. Thus, the results of these instruments complement each other in an ideal fashion. Improvements on both instruments, such as an infrared camera on TIRGO and a new reflector on KOSMA with an expected surface accuracy of 10 μm, will help to solve currently unresolved problems in astrophysics.

The Laboratory of Solar Physics is situated at the Jungfraujoch International Scientific Station in the Swiss Alps at an altitutde of 3580 m. The laboratory, maintained by the University of Liège, Belgium, is devoted to the study, at a very high resolution, of the solar spectrum in the visible and infrared with the improvement of the knowledge of the chemical composition of the sun's outer layers and the monitoring of changes in the abundance of various constituents of the earth's upper atmosphere as its basic objectives.

Epilogue

With this presentation of optics-related activities in Swiss industries and observatories, the series of special sections dedicated to Swiss optics comes to a close. The trilogy "Optics in Switzerland" presents a wide vision of optics as currently practiced in the country, good perspective, and a face of smiling optimism in the field. I hope that the trilogy will inspire an increase in dialogue and collaboration between different specialized groups in the country as well as promote international cooperation among scientists and engineers involved in similar and neighboring fields.

While writing these last lines, my sense of gratefulness knows no bounds. I wish to renew my thanks to all the authors for their scholarly contributions, to the referees for their timely assessment reports, to Professors Leopold Pflug and Brian Thompson for making this special section possible, to Miss Karolyn Labes for her courtesy and the numerous discussions and exchange of views I had with her through electronic mail, and finally to the staff of the SPIE for their helpful cooperation.



Pramod K. Rastogi received his MSc degree in physics from the University of Lucknow in 1973, his MTech degree in applied optics from the Indian Institute of Technology, New Delhi, in 1975, and his DEng degree from the University of Franche-Comté, Besancon, in 1979. He joined the Swiss Federal Institute of Technology, Lausanne, in 1978. His research activities are principally in the areas of holographic interferometry, speckle metrology, phase shifting, and moiré. He is the author or coauthor of more than 80 scientific papers of which more than 50 are published in peer-reviewed archival journals. He has authored several book chapters and has recently edited a book entitled *Holographic Interferometry — Principles and Methods* as a part of the Springer series in optical sciences. The book was published in May 1994. He was a guest editor of two special sections in *Optical Engineering,* "Optics in Switzerland, Part 1: Federal Institutes of Technology" (July 1995) and "Optics in Switzerland, Part 2: Universities and Research Institutes" (August 1995). He is preparing a special issue as a guest editor of the journal *Optics and Lasers in Engineering,* devoted to speckle and speckle-shearing interferometry. He is a reviewer of various scientific journals. He is a recipient of the Heténi award for the most significant research paper published in *Experimental Mechanics* in the year 1982. Dr. Rastogi is a Fellow of the OSA and the SPIE.