Optics in Switzerland, Part 2: Universities and Research Institutes

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"To bathe objects in light is to merge them with the infinite."
Leonardo da Vinci

The special section on Swiss optics was planned with the aim to provide *Optical Engineering* readers with an objective perception of the state of optics-related research and development activities currently in progress in Switzerland. Part 1 in the July issue was designed to provide a glimpse of optics-related activities in Swiss federal institutes of technology. The aim of this second section dedicated to optics in Switzerland is to present optics activities in the confines of Swiss universities and research institutes. The 22 papers in this special section cover a broad range of topics. A brief outline of the scope of activities being pursued by different groups follows.

At the Institute of Physics, University of Basel, research focuses on guiding laser spectroscopy toward ultrahigh spatial resolution and sensitivity. A highly sensitive scanning near-field optical microscope combined with a laser spectrometer has been developed for the purpose. The near-field optical properties of individual molecules and the interaction of these molecules with their local environment on a nanometer scale are investigated. The study should significantly contribute to a better understanding of light and matter on a nanometer scale, and provide the basis for the construction of novel optical detection devices.

The University of Bern has several important activities in optics. At the Institute of Biochemistry, research projects may be placed in the broad field of biomimetic technology. Research topics focus on surface bioengineering, biomimetic membranology, and biomaterials. Light-addressed immobilization of biomolecules is used for the construction of molecular devices and biosensors. Improvement of oriented immobilization, molecular guidance of cell growth, and the development of bioforce microscopy—a bio based tunnel microscopy approach for molecular surface control—are some of the research goals currently pursued at the institute. The Group of Microwave Physics at the Institute of Applied Physics is active in the field of microwave remote sensing. The main topic of research concerns the development of low-noise radiometers in the frequency range of 20 to approximately 200 GHz for the investigation of atmospheric trace gases. In this multidisciplinary area of research, special emphasis is given to the design of quasi-optical components, e.g., lenses, antennas, mixers, interferometers, etc., in the millimeter-wave region for applications in atmospheric remote sensing. Instruments for this purpose are operated from the ground and from the aircraft. At the Institute of Informatics and Applied Mathematics, the main emphasis of the Group of Vision and Artificial Intelligence is in the areas of computer vision, pattern recognition, and artificial intelligence. Particular research projects include image analysis and interpretation of printed documents, handwriting recognition, 3-D object recognition from gray-level and range images, structural matching algorithms, and expert systems. At the Institute of Physics, the main scientific interest of the Solar Wind Group is the analysis of solar wind plasma in relation to the origin and evolution of the solar system. The satellite-borne instruments measure the main constituents in the solar wind and interstellar gas. In particular, the elemental composition, charge state distribution, and the isotropic abundance of the plasma particles are investigated. Theoretical modeling and elaborate statistical analysis are used for the interpretation of the derived data.

The Institute of Applied Physics at the University of Bern hosts several groups in its laser department. The Laser Surgery Group studies the interaction of pulsed IR-laser radiation with tissue and the use of optical light guides for medical laser applications. This includes the investigation of laser-induced temperature and pressure-related tissue effects, dynamic changes in optical and mechanical properties of tissue, and experimental and theoretical studies of the ablation process. The activities of the Ultrafast Phenomena Group concentrate on the generation of ultrashort laser pulses in the wavelength range of 1.3 μm using rare-earth (Nd- and Pr-) doped optical fibers. The propagation and amplification characteristics of ultrashort 1.3-μm pulses in passive and active optical fibers are studied experimentally and theoretically. The Laser-Produced Plasma Group is primarily concerned with investigations on laser-irradiated microtubes for x-ray laser experiments using its 500-GW Nd:glass laser facility. This work is supported by developmental work on high-peak power, diode-pumped neodymium lasers. The Material Science Group studies the interaction of laser pulses with metal and the problems associated with the high-power excitation of diode-pumped solid state lasers. The Solid State Lasers Group studies the 2- and 3-μm emission from several multiply-doped crystals and glass fibers, all pumped with laser diodes or a Ti:sapphire laser. Beam shaping and new configurations with fibers are investigated. The Complex Fluids and Photon-counting Group develops time-correlated photon-counting methods. The methods include quasi-elastic light scattering, fluorescence correlation spectroscopy, time-resolved fluorescence depolarization, and optical time domain reflectometry.

The research directions at the Dalle Molle Institute of Artificial Perceptive Intelligence include various aspects of artificial intelligence, in which neural network research plays a major role. To benefit from the extremely high interconnection densities that are possible in optics, algorithms and optical architectures are investigated that enable implementing optical neural networks with state-of-the-art optoelectronic hardware. In addition, optical fiber sensing and its possible applications to optical interconnection devices are also investigated.

The European Laboratory for Particle Physics in Geneva hosts a highly technologically challenging world of particle accelerators and particle physics detectors. Specific problems with beam instrumentation and particle detectors have been addressed in collaboration with other research institutes, leading to the development of liquid, gas, and solid scintillator calorimeters, scintillating fibers with semiconductor or hybrid photodetectors, and Cherenkov detectors. Optoelectronic instrumentation for accelerators, such as very precise fiber optic transmission, picosecond lasers, and fast imaging devices (streak cameras or picosecond photoconductors), have also been developed.

Optics-related activities at the University of Geneva are few but important. The interest of the Computer Vision Group in the computer science department is in object recognition, mainly focusing on data reduction mechanisms for decreasing the amount of information required for indexing and recognizing objects. The work has found applications in agricultural robotics, automatic surveillance and traffic control, and medical imaging. The current interest lies in indexing and retrieval from large image databases, in the context of multimedia information systems.The optics section of the Group of Applied Physics works in different fields of research related to optical fibers. The activities range from theoretical quantum mechanics, cavity quantum electrodynamics, quantum cryptography, characterization of optical fibers (near field, refracted near field, and polarization mode dispersion), optical frequency domain refractometry, and fiber optical sensors for trace gas analysis. At the Institute of Physical Chemistry, the emphasis is on the study of the structural and electronic properties, and their time-dependent evolution, of transition metal and molecular impurities, in particular photochromic systems in inorganic crystalline materials. The study implies the use of high-resolution spectroscopy, paramagnetic resonance, x-ray crystallography, and thermodynamic techniques. Raman and impedance spectroscopy are applied to investigate high-temperature ionic conductivity in alkali sulfide single crystals.

The IBM Laboratory at Ruschlikon was the birthplace of near-field optical microscopy (SNOM) in the early 1980s. Transmission and reflection SNOM with very high resolution were demonstrated successfully, and the techniques developed at that time are still in use today. After a period of other activities, research in SNOM was resumed at IBM in 1992 in collaboration with the University of Basel and the Swiss Federal Institute of Technology, Zurich. Its main goals include efforts to improve the resolution and the understanding of SNOM with an emphasis on addressing new applications.

The research activities in applied optics at the Institute of Microtechnology at the University of Neuchâtel include diffractive and holographic optical elements (hybrid optics, optical interconnects, and beam shaping), optical information processing and optical computing (neural networks, optical parallel processors, and spatial light modulators), optical fibers and fiber optic systems (active fibers, lasers, amplifiers, and sensors), and high-resolution optical metrology (frequency-stabilized laser diodes, multiwavelength and white light interferometry).

At the Paul Scherrer Institute, projects in the Applied Solid State Physics Department focus primarily on the application of III-V technology, micro-optics, integrated optics, and image sensing techniques to optical sensing and metrology. Special strengths include replicated micro-optics and application-specific optoelectronic devices.

At the Swiss Federal Laboratories for Materials Testing and Research, the field of activity is best described by research toward adaptation of optical techniques to various problems in materials testing, with special emphasis on calibration and validation. A group in fiber optics directs its research toward distributed sensing.

The Swiss Federal Office of Metrology is the national standard laboratory. In the field of dimensional metrology, stabilized lasers are developed for realizing and maintaining the definition of the meter. Research activities focus mainly on applications of laser interferometry, such as the development of an interference refractometer or an interference dilatometer. In the field of optical metrology, the radiometric and photometric units of radiation are realized. This includes spectroradiometric calibration of light sources and calibration of the spectral responsivity of detectors.

At the Physics Institute of the University of Zurich, there is an active interest in the study of temporal and spatial nonlinear behavior of electromagnetical systems that may show chaos. An NMR laser running at a frequency as low as 12 MHz provides an ideal test system to investigate a variety of temporal nonlinearities. To extend research toward spatial and spatiotemporal effects, circularly polarized laser beams interacting with sodium vapor are used.

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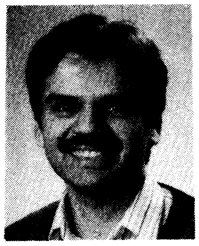

Pramod K. Rastogi received his MSc degree in physics from the University of Lucknow in 1973, his MTech degree in applied optics from the Indian Institute of Technology, New Delhi, in 1975, and his DEng degree from the University of Franche-Comté, Besancon, in 1979. He joined the Swiss Federal Institute 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 the guest editor of a special section "Optics in Switzerland, Part 1: Federal Institutes of Technology" (July 1995) in *Optical Engineering.* 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 also a reviewer of various scientific journals. He is a recipient of the Hetényi 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.

Erratum

We regret that the following errors appeared in Dr. Rastogi's first editorial, "Optics in Switzerland, Part 1: Federal Institutes of Technology," in the July issue of *Optical Engineering*.

The last sentence beginning on page 1867 and the remainder of the paragraph continuing on to page 1868 under the heading "The Swiss Society for Optics and Electron Microscopy" should read

> "The society edits a quarterly bulletin, holds regular meetings, and provides specialized courses in optics. As for the evolution of the membership of the society, its number of individual members has gone up from 41 in 1956 to 639 in 1994, and its corporate membership has jumped up from 7 in 1956 to 69 in 1994."

The last sentence on page 1868 should read

> "This fact has certainly played a role in fueling the enthusiasm coupled with the high scientific and technical reputation of *Optical Engineering.*"