ICO Newsletter

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Summary

International Commission for Optics.

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Optics

Closely following the report "Harnessing Light" published by the United States National Research Council, the new ICO statutes define "Optics" as "the field of science and engineering encompassing the physical phenomena and technologies associated with the generation, transmission, manipulation, detection, and utilization of light. It extends on both sides of the visible part of the electromagnetic spectrum as far as the same concepts apply.

With this definition, Optics is a broad field, arguably even a scientific "discipline". It is sometimes useful to distinguish between various aspects of optics or to promote the idea that the field was really revolutionized by technology, in particular by the laser and the optics fiber, whence such words as "photonics", "optoelectronics", "photophysics", or sometimes "optronics". Whence also the common usage of expressions such as "optical technology", "optics and photonics", and more. Do the Newsletter readers agree, however, that optics is the broader of all these concepts? Please do not hesitate to contribute to the discussion: this newsletter may offer a forum to those wishing to share complementary or contradicting views.

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Last minute information: Lukin to be ICO Galileo Galilei award winner for 2000

The 2000 ICO Galileo Galilei award has been announced: the winner is Vladimir Lukinof the Siberian Branch of the Russian Academy of Sciences, Tomsk, Russia. Following the award spirit and definition, he is being recognized for his scientific contributions under comparative unfavorable circumstances on light propagation through turbulent media and on adaptive optics. The next issue of this Newsletter will provide more detail.

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ICO 2000 Prize winner : Stefan Hell

The 2000 Prize of the International Commission for Optics has been awarded to Stefan W. Hell of the Max-Planck-Institute for Biophysical Chemistry in Göttingen Germany in recognition of his innovative work on increasing resolution in far field optical microscopy.

Stefan Hell's primary scientific goal is to overcome Abbe's famous resolution limit and to push the resolving power of *far-field* light microscopy to the tens of nanometer scale. Far-field fluorescence microscopy is highly relevant to biological sciences because, in contrast to electron, atomic force and near-field optical microscopy, it is able to visualize the interior of living specimens at the submicron scale in 3D. Not surprisingly, 3D versions of far-field light microscopy, such as the confocal and the multiphoton fluorescence microscope play a key role in uncovering the secrets of life at the sub-cellular level, so that the improvement of their resolution is of fundamental importance.

Stefan Hell was born in 1962. He studied physics at the University of Heidelberg, where he received his Diplom (Masters degree) in 1987. While continuing as a PhD student in physics with Prof. Hunklinger in Heidelberg, Stefan Hell realized that the spatially confined, probe-like point-spread-function of a scanning confocal microscope is a good starting point for surpassing the fluorescence microscopy resolution limits. After receiving his Ph.D. in 1990 he set out to explore these potentials in theory and practice. The concepts for improving the resolution known at that time, such as superresolving pupil filters and short wavelengths multiphoton excitation were difficult to match up with real world conditions and therefore remained mostly of academic interest.

Hell's approaches are not only intellectually appealing, but also have become practically relevant. His research strategy encompasses the introduction of theoretical concepts, their experimental verification, and practical application. Thus, he was arguably the first in many decades to systematically readdress the resolution problem in *far*-field fluorescence microscopy. In 1990 he introduced the idea of 4Pi-confocal microscopy, which by coherently adding the illumination and/or detection aperture of two lenses, improves the axial resolution by 3 - 7 times over that of the best confocal microscope. To explore this idea experimentally he joined the European Molecular Biology Laboratory (EMBL) in Heidelberg as a postdoctoral researcher where he demonstrated first operational principles. In 1993, the Department of Medical Physics at the University of Turku, Finland lead by Prof. Soini and the Finnish Academy of Sciences enabled him to establish a small research group dedicated to far-field resolution improvement. The group soon became one of the most active in the field of microscopy. During this time he also introduced the concept of Stimulated-Emission-Depletion Microscopy (STED) the basic idea of which is to reduce the extent of the focal spot by 'switching off' fluorescence from its rim. He predicted that STED microscopy should break the diffraction barrier in far-field fluorescence microscopy by about five-fold, which he and his collaborators demonstrated experimentally a few years later.

In 1995, Stefan Hell spent six months as a visiting scientist in Tony Wilson's laboratory at the University of Oxford, England. In 1996, while still leading the group in Finland, he received his *Venia Legendi* (Habilitation) in Physics at the University of Heidelberg, where he has been a lecturer since. In his Habilitation thesis and in a subsequent review article, he coined the notion of 'Point-Spread-Function Engineering' which means the deliberate change of the spatial extent and shape of a scanning microscope's fluorescence spot towards a narrower extent: this is the philosophy underlying most of his work. In 1997 he returned to Germany following an invitation from the Max-Planck-Society to establish an independent research group at the Max-Planck-Institute for Biophysical Chemistry in Göttingen.

With the 4Pi-confocal microscope, Stefan Hell and his collaborators demonstrated 3D-imaging of actin filaments and microtubules in fibroblast cells with a 4-fold sharper sectioning than that of high-end confocal microscopy. Introducing image restoration techniques, the resolution could be increased even further, so that for the first time, a 3D-resolution of the order of 100 nm was achieved. For biological applications the spatial resolution of the 4Pi-confocal microscope is of the same order as that of practical near-field optical fluorescence microscopy, however, the key advantage here is that this resolution is achieved in 3D and in the cell volume. Likewise, developing STED-fluorescence microscopy, the Göttingen group has now realized fluorescence focal spots that are 2.5 times narrower than confocal in the transverse direction and up to 5 times narrower along the optic axis. These experiments constitute the first clear breaking of the diffraction barrier in far-field fluorescence microscopy. Calculations predict that these are not principle limits and even higher spatial resolution should be possible. Interestingly, besides biological imaging this approach may also be applicable to increasing the density in optical data storage and producing finer linewidths in microlithography.

By authoring and co-authoring more than 70 peer-reviewed, original publications, 5 book chapters and 6 patents Stefan Hell has significantly contributed to 3D-microscopy and related fields in biomedical optics as a whole. In addition to the 4Pi and STED techniques, he has introduced a novel multifocal version of multiphoton microscopy, which delivers real-time, direct-view images from the interior of live cells without trading off resolution against speed. He and his team further helped to establish sample compatibility parameters in nonlinear microscopy and contributed to designing novel time-resolved fluorescence microscopes with femtosecond temporal resolution. Applied to biomedical sciences, their microscopes will further contribute revealing the relationship between structure and function at the subcellular level. Stefan Hell's vision is to devise and realize far-field optical microscopes that will ultimately enable the *non-invasive* observation of the mechanisms of life at the tens of nanometer scale.

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History, activities and organization of ICO members:

Under this heading, the ICO Newsletter publishes reports on ICO members, which include the ICO Territorial Committees and the ICO International Society Members. This issue of the Newsletter has reports submitted by the Argentinean, Danish and Russian Territorial Committees, while previous issues published contributions from the Chinese Optical Society, Cuban, Finnish, French, Iranian, Italian, Korean, Polish, Spain, Swiss, Turkish, Ukrainian and US Territorial Committees. The other ICO members are strongly encouraged to contribute to this column with reports and illustrations.

Argentina: About the Argentinean Territorial Committee of ICO

Even though Argentina is a large country, it has a small population and this is one of the main reasons why Argentina does not have a professional society for optics. The Asociación Física Argentina (Physics Association of Argentina) established in 1949 is the local society for physics and includes several divisions. The Divisions of Optics and Photophysics include the majority of the optical scientists doing research and development in these fields in the country, with a total membership standing at about 150. Both divisions play an important role in the dissemination of optical and photophysics knowledge through regular meetings and other activities. Most of their members have carried out postgraduate work in several European countries and in the United States and, as a result, are heavily involved in international collaboration and programs.

The country joined the International Commission for Optics in 1980. At present, the Territorial Committee is elected by the members of the Executive Committees of the two above-mentioned divisions of the Asociación Física Argentina: each division elects three members for a two year term. This procedure ensures the representation of most of the national scientific community working in the fields of optics and photophysics. In addition, one national representative is in charge of the ICO relations. The acting and the future national representatives also form part of the Territorial Committee and they are elected by vote opened to all members of the optical and photophysics community. Every three years a new future representative is elected and incorporated to the Territorial Committee, while the former acting member leaves it.

The Territorial Committee's main objectives for the coming year involves the organization of the IV Iberoamerican Meeting of Optics (IV RIAO) and VII Latin-American Meeting of Optics, Lasers and their Applications (VII OPTILAS) to be held in Tandil on 3-7 September 2001. The aims of these meetings are:

i. to present and to analyze the most recent developments carried out by the Iberoamerican community in the different fields of optics and photophysics, including industrial and bio-medical applications,
ii. to promote contacts and collaboration between the different research groups within the region and to debate new ideas which will boost the technological development of the associated disciplines,
iii. to stimulate the participation of young researchers in applied subjects of high academic interests and technological relevance. Both meetings are cosponsored by the Agencia Nacional de Promoción Científica y Tecnológica (National Agency of Scientific and Technological Promotion), ICO, the Optical Society of America, SPIE-The International Society for Optical Engineering and several national universities and research centers. Other organizations whose participation has been requested include the International Centre of Theoretical Physics, Centro Latinoamericano de Física (Latinoamerican Centre of Physics) and the Consejo Nacional de Investigaciones Científicas y Técnicas (National Council of Scientific and Technical Research) and several optical and laser companies.

Prof. Guillermo H. Kaufmann, ICO National Representative, guille@ifir.ifir.edu.ar

Denmark: the Danish Optical Society (DOPS) - a brief introduction.

The Danish Optical Society (DOPS) is a professional organisation of persons, institutions and companies working with optics in Denmark. DOPS was founded in 1986 and has from the very beginning been the most important forum in Denmark for activities related to the scientific and technical aspects of optics.

DOPS is an independent Danish professional organisation supporting the interests of optical research and applications. The number of members has been very stable, about 220 members: 20 companies, 10 Institutes, 145 individual members and 45 students. An executive committee elected at the annual general assembly governs DOPS and it is currently administered by the Centre for Advanced Technology (CAT) at Risø National Laboratories.

Relations

DOPS is a learned society member of the European Optical Society (EOS) and has close cooperation with a number of other optics societies and scientific organisations such as the Danish Physical Society and the Swedish Optical Society.

Purpose

DOPS is dedicated to

- supporting the wide range of optics in Denmark, in regard to both research at the highest international level and industrial and commercial applications of optics,
- arranging post graduate courses, topical meetings and short courses to help scientists and engineers stay current with the latest scientific and technical developments in optics and to support and encourage its many student members,
- co-sponsoring international conferences in co-operation with other national and international professional societies.

Activities

The *DOPS Annual Meeting* is the most important DOPS activity of the year. It is a one- or two-day meeting held in the last week of November. The meeting includes invited international guest speakers reviewing selected topics of current interest, local speakers and a commercial technical exhibition, where DOPS members and representatives of national and international commercial suppliers can get in contact.

The annual meeting is furthermore the occasion to honour extraordinary contributions to optics by, e.g., the awarding of the DOPS-prize. *DOPS-NYT* is the official membership journal of DOPS. It is issued four times a year and sent to all members of DOPS and to a number of libraries and organisations. Through DOPS-NYT the members are kept informed of technical and scientific matters of general interest to optics, short courses as well as on a range of other topics of interest to the Danish optics community. .

DOPS Short Courses are organized at the initiative of DOPS or by request from a company;

In short, the DOPS profile is one of a professional society with a high professional standard and a wide range of interests spanning in equal measure from scientific matters through technical and applied optics to education.

Homepage: http://www.dops.dk.

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Russia: the ICO Territorial Committee in Russia

The adhering body for the ICO in Russia is the Scientific Council on Optics and Laser Physics (SCOLP) of the Russian Academy of Sciences. The Council had evolved in 1999 from the Scientific Council on Coherent and Nonlinear Optics, that played a crucial role in the advancement of optics and laser physics in USSR. SCOLF comprises members from the Russian Academy of Sciences, universities and industry and representatives from the Optical Society of Russia, Laser Association, SPIE/Russia and the United Physical Society of the Russian Federation. The scientists participating in the Council represent practically all regions having optical institutions and centers. Some Republics of the FSU also represented in SCOLF.

The main goal of SCOLF is to consolidate the optical community of Russia for solving fundamental and applied problems of optics and laser physics, and to integrate it into high technologies and world science.

The important aspects of the ICO Russian Territorial Committee activity include promotion of optical and laser sciences achievements for human prosperity and health as well as participation in organizing international and national conferences in Russia such as the following:

*International conference on coherent and nonlinear optics(**ICONO**),* a series of 15 meetings so far, of which the latest was held in Moscow in 1998. The next (16th) is planned in 2001 in Minsk (Belarus),

*International symposium «Modern problem of laser physics» - **MPLP***(usually held triennially in Novosibirsk, Siberian region),

*International conference on laser optics-**OL*** (triennial in St.Petersburg),

*International conference on lasers, applications and technologies- **LAT*** (triennial in Shatura, Moscow region) and other events.

The Territorial committee will also play an important role in the organization of the 2002 *International quantum electronics conference **(IQEC'2002),*** which will be collocated with the *International conference on lasers, applications and technologies**(LAT'2002)*** from 22 to 28 June 2002 in Moscow.

Other significant aspects of the Territorial committee activity include:

- supporting young scientists and students in their research and conference participation;
- forming programs on optics, laser physics and optical instrumentation for Russia and FSU;
- promoting cooperation between scientific institutions, universities and industrial firms in developing new high technologies based on optics, optoelectronics and laser physics;
- promoting optical education and training;
- expert activity in forming of international and national programs.

Russian Territorial Committee is looking forward to being directly involved in ICO events in future, including the ICTP/ICO/OSA Winter College, the traveling lecturer program and other ICO activities.

Sergei Bagayev, Chairman, ICO Territorial Committee, Russia.

Note: there was a misprint in the April 2000 issue of the ICO Newsletter concerning the e-mail address for the ICO Territorial Committee in Russia. The correct address is zolotov@kapella.gpi.ru

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Forthcoming events with ICO participation

9-11 January 2001 **Optics in Computing 2001** Lake Tahoe, Nevada, USA General Chair: F.A. Tooley, Heriot-Watt Univ., UK Wendy Yanis, OSA, 2010 Massachusetts Ave, NW, Washington, DC 20036, USA fax. +1 202 416 6100, wyanis@osa.org
Web: http://www.osa.org/mtg_conf/2001/OC/

10-13 May 2001 **5th Int'l Conference on Correlation Optics** Chernivtsy, Ukraine Prof. Oleg V. Angelsky, Correlation Optics Dept., Chernivtsy University, 2 Kotsyubinsky Str., 274012 Chernivtsy, Ukraine fax. +380 3722 44730 oleg@optical.chernovtsy.ua

3-7 September 2001 **IV RIAO / VII OPTILAS** Tandil, Argentina Prof. G.H. Kaufmann, Inst. de Física Rosario (CONICET-UNR), Bvd. 27 de Febrero 210 bis, 2000 Rosario, Argentina fax. +54 341 482 1772, guille@ifir.ifir.edu.ar secretariat riop@exa.unicen.edu.ar
Web: http://www.df.uba.ar/riop2001/

9-14 September 2001 **ICO Topical Meeting, Information Optics** Ceasarea, Israel Prof. Asher A. Friesem, Department of Physics of Complex Systems, Weizmann Institute of Science, Rehovot 76100, Israel fax. + 972 8 934 4109 friesem@wicc.weizmann.ac.il

27-30 November 2001 **7th Conf. on Education and Training in Optics and** Photonics (ETOP 2001) Singapore Dr. Tuan-Kay Lim, School of Electrical and Electronic Engineering, Nanyang Technological University, Nanyang Ave., Singapore 639798 fax. +65 791 2687/792 0415 etklim@ntu.edu.sg
Web: http://spie.org/info/etop/

17-22 March 2002 **Optics in Computing 2002** Hsinchu, Taiwan Prof. Chung J. Kuo, Graduate Institute of Communication Engineering, National Chung Cheng University, Chaiyi, Taiwan 62107 fax. +886 5 272 2702 kuo@ee.ccu.edu.tw

25-31 August 2002 **ICO-19, Triennial Congress of the** International Commission for Optics "Optics for the Quality of Life" Florence, Italy Dr. Giancarlo C. Righini, IROE "N. Carrara" - CNR, Via Panciatichi 64, I-50127 Firenze, Italy fax. +39 055 412878 righini@iroe.fi.cnr.it

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