NEWSLETTER

Commission Internationale d'Optique • International Commission for Optics

Young Soviet laser scientists in the '60s

P G Kryukov, one of N G Basov's graduate students at the time immediately following the discovery of the ruby laser, shares his remembrances.

The creation of the laser is an outstanding achievement in the development of science and technology. The laser story is quite dramatic. I want to tell about some facts known to me concerning the story of laser studies at the Lebedev Physics Institute (FIAN) of the Academy of Sciences of the former Soviet Union.

N G Basov and A M Prokhorov, research scientists at the institute, were already well known scientists who developed the ammonia maser independently of C Townes and his colleagues in the US. They were awarded the highest scientific prize of the USSR, the Lenin Prize, and headed large research groups involved in active investigations in the field of quantum electronics. However, these studies were performed in the radiofrequency spectral range, and not all of the researchers were eager to enter the field of optics and spectroscopy, which was new for them. It is not surprising that the first laser in Russia (at the time, part of the USSR) was made at the State Optical Institute (GOI) in St Petersburg (Leningrad at that time) in the middle of 1961.

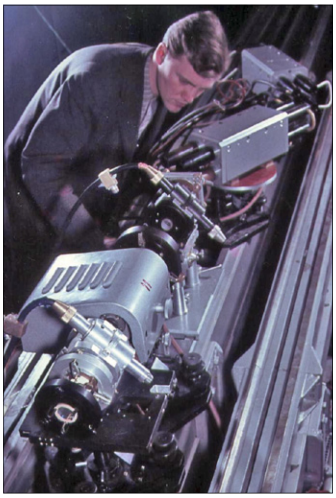
After T Maiman demonstrated the first operating laser in 1960, Basov proposed that researchers at the Laboratory of Luminescence at FIAN construct and investigate a ruby laser. As a result, the ruby laser was successfully operated by V D Galanin, A M Leontovich and Z A Chizhikova at the Laboratory of Luminescence on 18 September 1961.

The required ruby samples, measuring 4 × 4 × 20–25 mm, were cut from synthetic ruby crystals that were used in watches. The optical quality of these samples was poor, and it was very difficult to select satisfactory crystals. Pumping was performed by standard xenon flash lamps, such as those used in aircraft landing systems in airports. The polished ends of samples were covered with silver layers deposited in a vacuum, the transmission of the output mirror being determined by heuristic rules. This laser demonstrated the specific features of the ruby laser, such as a lasing threshold, beam directionality and a series of short spikes in the time-dependence of the output emission.

I joined FIAN early in the summer of 1961 after graduating from the Chair of Optics at the Department of Physics at Lomonosov Moscow State University. At this time Basov was insistently developing the concept of a semiconductor laser, and he accepted me to work in a research group engaged on this problem. It happened that I was immediately drafted for a three-month course of military training for officers. Physics students were educated in radar systems at the Military Chair. We studied, in particular, an analogue of the SCR-534 American radar, which was supplied to our country during World War II under the lend-lease programme. Knowledge of radars proved to be very useful for me, an optics specialist, because the most important methods of lasing, such as Q-switching and mode-locking, were developed to a great extent under the influence of radar principles, and the chirped-pulse amplification method has a direct analogue in radar technology.

Charles Townes (left) visiting FIAN in 1965, with then-graduate-student Letokhov (centre) and Basov (right).

Letokhov (back) explains to Townes (front) the phenomenon of superluminal laser pulse propagation in a saturated active medium during his 1965 visit to FIAN.



Petr Kryukov and his experimental set-up for a Q-switched laser in 1962.

Letokhov (centre) and Ambartzumian (right) demonstrating their set-up to Prokhorov (left).

At that time and continuing until much later, a seminar headed by Prokhorov was very important for the development of quantum electronics. At the beginning of September 1961, Basov and co-workers discussed at this seminar the concept of a Q-switched laser. They proposed inserting into the laser cavity two converging lenses and a rapidly rotating disc with a hole placed at their common focus. This was a possible way to implement the idea put forward by R W Hellwarth, which promised a considerable increase in the peak output power. It was very important because Basov and O N Krokhin were developing the concept of plasma heating by high-power laser radiation. Basov commissioned his young staff member V S Zuev to build a high-power ruby laser and appointed me as his assistant.

Supported by the kind staff at the Laboratory of Luminescence, we assembled our set-up in a short time and began to move toward our goal of increasing the output peak power. We achieved a few rather important results at that time. Because the laser should work with external mirrors, it was necessary to learn how to handle them. We used mirrors with maximum reflectance, and laser radiation was coupled out with the help of a tilted glass plate. This arrangement allowed us to reduce the lasing threshold and obtain the optimal output coupling. As a result, we managed for the first time to burn through a razor blade using focused laser radiation.

As for the Q-switching scheme, we built a set-up with a rotating disc and obtained in 1962 the first, though rather modest, result. We were engaged simultaneously in the development of a Kerr Q switch, but we encountered difficulties it its fabrication and control. We had at our disposal a high-voltage radar modulator, but it produced voltages only up to 20 kV, whereas we needed about 50 kV. One day N G Basov told us that the Americans had already made this "toy". He was referring to a paper by F J McClung and R W Hellwarth in which they reported the generation of a giant pulse with the help of a Kerr Q switch in 1962.

Letokhov at his promotion ceremony on 27 May 2005 in Lund, Sweden.

At the same time laser studies in the former Soviet Union were expanding. Rapid progress became possible owing to effective co-operation with several scientific and technological institutes, including GOI and the Krasnogorsk optics mechanical plant. A special building (the Pavilion) was constructed in FIAN. A huge optical bench and supply sources for many flashlamps were situated in it. R V Ambartsumian, a graduate of the Moscow State University, and V S Letokhov, a student of the Moscow Institute of Physics and Technology, joined our group. Ruby crystals, specially designed for lasers, were manufactured in a number of institutes. P P Pashinin visited the US and subsequently built a Q-switched laser with a rotating prism. The laser design was simple and very efficient. Focused laser radiation produced an electric breakdown in the air, making an exciting impression on all observers.

The question arose whether it was reasonable to continue the development of the Kerr Q-switch and I want to emphasize here that we were immune to this temptation. We learned that G A Mesyats and his associates at the Tomsk Polytechnical Institute had built a generator producing 50 kV pulses with nanosecond wavefronts. We applied to them for this generator and received it, and then managed to operate a Kerr Q-switched laser emitting output powers exceeding that of the Q-switched laser with a rotating prism. And our laser could also produce a spark in the air.

In connection with this I remember a funny anecdote. A laser conference was held at FIAN in which scientists from Moscow and other cities took part. Basov reported our achievement at the conference. However, Prokhorov said that he did not trust Basov's claim and wanted to see immediately a laser spark, which was treated as the power criterion. So, quite unexpectedly, Prokhorov, Basov and other participants at the conference walked into our laboratory. Prokhorov demanded a demonstration of our system. Every experimentalist knows the unreliable behaviour of homemade devices and the high probability of the so-called "visit effect". Fortunately, the laser operated well and produced a loud spark in the air. "Well, a little one is produced," said Prokhorov. But one of the other visitors said "No, Aleksander Mikhailovich, the spark is bigger than in your lab." "Really? Repeat!" We repeated the shot and again successfully produced a spark. But now Prokhorov noticed that our set-up consisted of two parts: the laser itself and the second identical ruby crystal, which was used as an amplifier. He asked, "Can you produce the spark without the amplifier?" We assured him that we could. "Remove the amplifier," he demanded. This time we failed to initiate the spark. We began to explain that careful adjustment of the laser is required, but Prokhorov was adamant: "Eve-

Prof. Vladilen S Letokhov and V P Chebotayev, winners of the Lenin State Prize in 1978.

Petr Georgievitch Kryukov was born in a small town in Siberia. He started his career as a researcher on laser physics working for Prof. N G Basov. He took active part in the development of the first mechanically Q-switched ruby laser.

rything is clear. The spark can be produced by using the amplifier and cannot be produced without it. Thank you". We understood that he proposed an "honorary dead heat", or tie, and decided that there was no reason to reject it.

It was assumed that the peak power of a laser pulse will be increased during amplification not only due to the increase in the pulse energy but also due to the pulse shortening caused by the predominant amplification of the leading edge of the pulse. We acquired from the GOI two unique ruby rods 240 mm long with leucosapphire ends cut at the Brewster angle. They provided such a high gain that lasing was achieved even when one of the resonator mirrors was replaced by a white paper sheet. In this way, we discovered a new type of non-resonance feedback laser. Letokhov developed the theory of this laser, and R V Ambartsymian used the results of these studies in his thesis.

To investigate the amplification process, a detector and an oscilloscope with nanosecond time resolution were required. We had a special photocell (bomb photodiode) and a single-beam oscilloscope. To record the input and output signals in one trace, the output radiation was delayed by a system of mirrors. We were amazed to see that the pulse shape did not change noticeably during amplification, but the amplified pulse definitely shifted toward the input pulse on the oscilloscope trace. It appeared that the laser pulse propagated in the amplifying medium at a velocity exceeding the speed of light. Letokhov explained how this phenomenon would depend on the shape of the input pulse. Our further studies showed that, depending on the input pulse shape, the output pulse can either shorten or expand and even retain its shape, but propagating at a velocity different from the speed of light.

For the pulse shortening it was necessary to cut the front part of the input pulse. This was done using a second Kerr shutter. Now our setup had the appearance shown opposite (which also shows me when I was young). You can see the master oscillator with a Kerr Q switch, the second Kerr shutter to cut the leading edge of the pulse, and two stages of the final amplifier. Later we used a bleachable dye solution instead of the second shutter. Investigations of pulse propagation under conditions of saturable amplification and saturable absorption became the basis for Letokhov's theory of the fluctuation mechanism of passive mode-locked laser operation.

In 1969 Letokhov wrote his thesis on the theory of laser pulse generation and amplification. There are two types of science degree in Russia: candidate of sciences (equivalent to a PhD) and doctor of sciences (a postdoctoral degree, with no real equivalent in the UK or US). Letokhov wanted to earn the doctor degree straight away. But the academic council did not break tradition and bestowed on him instead the candidate degree. The following year he presented a new version of his thesis and received a doctor degree. In 1970 Prof. S Mandelstam, head of the Spectroscopy Laboratory in FIAN, organized the new Institute of Spectroscopy in Troitsk (a Moscow district) and asked Letokhov to join the institute as a laboratory head. Letokhov showed his character again. He wanted to be a deputy director and head a whole laser spectroscopy division. Mandelstam accepted his condition.

With his co-workers, Letokhov made decisive contributions to the development of methods of selective laser chemistry, including isotope-selective multiphoton dissociation of gas molecules by IR laser radiation. Letokhov and his colleagues suggested and developed methods of laser control of atomic motion, resulting in creation of atom traps based on gradient forces. His group carried out the first experiments on cooling, collimation and the reflection of atom beams by laser radiation. He became Doctor Honoris Causa of the Université Paris-Nord in 1995 and of Lund University, Sweden, in 2005. Unfortunately the Russian Academy did not vote him into its membership. He died in 2009.

P G Kryukov, Fibre Optics Research Centre, Russian Academy of Sciences

Special thanks to Prof. Konstantin Vodopyanov, Stanford University, for initiating contact with Prof. Kryukov.

Optics is flourishing in Tunisia

Tunisian optics is taking off with a new student chapter and ETOP 2011.

Optics and photonics research in Tunisia has been gradually growing over the last 10 years. Despite relatively low funding, optics research is competitive according to many international benchmarks and has had a significant impact on the whole African continent.

The engineering school of communication of Tunis (Sup'Com) is the leading engineering school in information and communication technologies. Located in the main Tunisian technopark, Sup'Com has a very active research group, led by Mourad Zghal, in the fields of optical fibre communications and photonics components for telecommunication-based applications. The group works in close collaboration with the Abdus Salam International Centre for Theoretical Physics, the laser laboratory at Elettra Synchrotron in Trieste, and the Nelson Mandela Metropolitan University in South Africa. In addition to scientific publications, the group focuses on research topics related to the needs of local industries

The Tunisia Student Chapter at Sup'Com. From left: A Gueddana, M Grissa, C Rebai (head of physics department), R Cherif (OSA chapter president), J Dudley (OSA travelling lecturer), A Reguigui (behind), M Zghal (OSA chapter adviser), T Khemissi, N Neji, R Ben Abdesslem.

for the development of the national optical network for telecommunications. Although there are relatively few companies in Tunisia that focus solely on optics, optics research is enabling the development of other well established industrial sectors.

In 2002, the Tunisian Optical Society (TOS) was founded by a group of researchers and faculty members. TOS is the leading body representing the field of optics in Tunisia. It represents Tunisia at ICO, of which Tunisia has been a member since 2006. One of its major future activities is the organization of the 2011 Education and Training in Optics & Photonics (ETOP) conference, which will be held in July in the beautiful Mediterranean city of Carthage. ETOP is a biennial conference that brings together educators from around the world to share information about the practice of teaching optics at all levels. The 2011 meeting will be the first held in Africa. The conference will be co-located with the first EOS Topical Meeting on Photonics for Sustainable Development – Focus on the Mediterranean (PSDM 2011). ETOP 2011 will be chaired by Zohra Ben Lakhdar and co-chaired by Mourad Zghal. ETOP is co-sponsored by ICO, OSA and SPIE, and recently IEEE Photonics has joined the ETOP Steering Committee for sponsorship, contributing to this unique joint venture.

Last year Mourad Zghal and his PhD student Rim Cherif were able to establish the first OSA and SPIE student chapter in Tunisia – the second in Africa. These two chapters are very active and have invited speakers from OSA to local events and have initiated OSA- and SPIE-sponsored educational outreach activities in optics. For example, under the OSA lecturer programme, the OSA Tunisia student chapter invited John Dudley from Université de Franche-Comté in France to give a lecture on supercontinuum generation in photonic crystal fibres for a large number of students at Sup'Com. The students have also organized a series of demonstrations related to optics and presented posters dealing with the activities of the group in order to recruit more students to their chapter.

Tunisia has a very active optical community that plays a key role in developing photonics science and technology in the country and throughout Africa. Tunisian researchers want to become members of the worldwide optics community by participating at international conferences and by working collaboratively with their international colleagues on exciting research for the benefit of society.

Mourad Zghal, Engineering School of Communications of Tunis, Tunisia

Obituary: Sang Soo Lee

"Founder of optics" in Korea passed away on 7 May 2010.

After devoting more than 40 years to laying a solid foundation for optical sciences research, industry and education in Korea, Dr Sang Soo Lee, known as the "Founder of optics" by Korean academia and industry, passed away on 7 May in Seoul, at the age of 84.

Dr Lee received a BS in physics from Seoul National University in Korea in 1949 and became the first Korean to receive a PhD in optics from the Imperial College of Science and Technology, University of London, UK (1959). Dr Lee devoted his life to serving as educator, researcher and administrator in science policy. He started his career as head of

the Physics Research Division at the Korea Atomic Energy Research Institute (KAERI) in 1960 and became a director in 1967. He also held the position of director general of the Office of Korea Atomic Energy (1970–71). Dr Lee was one of the founding members of the Korea Advanced Institute of Science and Technology (KAIST) and became its first president in 1971. At KAIST he led an optics research group as a faculty member in the physics department, where he stayed until he retired. He played a pivotal role in the founding of the Optical Society of Korea (OSK) in 1989 and served as its first president.

At KAIST Dr Lee mentored 50 PhD and more than 100 MS students, many of whom have played important roles in the Korean optics community as members of academia, government research institutes and major industries. Dr Lee's former students are now leading optics and photonics technology in Korea, especially in the areas of optoelectronic semiconductors and display, as well as optical communication and optical storage.

Dr Lee also played an active role in the international scientific communities by serving as a vice-president of the International Commission for Optics, as a council member of the Third World Academy of Sciences, and as a council member of UN University. He willingly gave precious time to serve as an ambassador for the optics community and as a role model for people seeking to bridge the developing countries and leading nations in optical science and technology.

Dr Lee was a Fellow of the International Society for Optical Engineering, the Optical Society of America (OSA) and the Korean Physical Society. He was the recipient of many awards and honours, including the National Order of Civil Merit that is the presidential medal of honour from the Republic of Korea (2000), the Songgok Academic Achievement Prize, the Presidential Award for Science and the Medal of Honour for Distinguished Scientific Achievement in Korea. In 2006 he was awarded OSA's Esther Hoffman Beller Medal in recognition of his outstanding contributions to optical science and engineering education.

Topical meetings come to Paris

ICO and EOS organize a Topical Meeting on Optics and Energy to be held in Paris as TOM 7 at EOSAM 2010.

The 21st century is the century of photonics and of the revolution triggered by energy resources. Sustainable technologies based on optics and photonics promise a challenging future. These new technologies, incorporated into devices for energy production, involve fundamental physics such as the interaction of matter with radiation, with particular emphasis on photon optics, physical properties of materials in the optical band, the physics of semiconductors and new photo-materials. Those fundamental issues concern basic physical processes such as the photovoltaic effect, which is currently being revisited for new flexible designs and devices.

Related new emerging technologies include silicon photonics, structures for the harvesting of light, solar energy, and the design and fabrication of optical elements with high optical performances (such as photovoltaic concentrators). This is just a brief sketch of the vast field of optics and energy covered in the core lectures of the forum.

There is in addition another interpretation of the subjects mentioned. The global economy is facing a period of challenges, and scientists are urged to provide answers and initiatives by facilitating the feasibility of a wide dissemination of new sustainable energy transfer of technology. In this challenge, no restrictions apply, and both developed and developing societies may share the new future, assuring a better quality of life.

ICO has as its main objective support for the dissemination of optics and photonics all over the world. The ICO/EOS Topical Meeting (TOM) on Optics and Energy is a new venture. It is chaired by Maria L Calvo, ICO president, and Duncan Moore, chair of the ICO Committee for Regional Development. It will be held at the EOS annual conference, EOSAM 2010, and will offer, for the first time, a forum for all scientists, young researchers, technicians and indeed anyone interested in this important field.

EOSAM 2010 will also host the ICO Prize and Galileo Galilei Award ceremonies, including the 2009 awardees' Ernst Abbé and Galileo Galilei lectures, on Thursday 28 October. The titles and abstracts of the lectures can be found on the ICO website.

The Optics and Energy TOM is also sponsored by the International Union of Pure and Applied Physics, which is offering grants for physicists from developing countries to attend the conference. For more information about the meeting, visit www.myeos.org/events/eosam2010-TOM7.

ICO solicits bids for organizing ICO-23

Territorial committees are invited to host the 2014 ICO Congress.

ICO congresses are held every three years. The congress consists of a scientific conference, which covers the wide disciplinary field of optics in its entirety, and the general business meeting required by ICO statutes. ICO is soliciting and accepting bids from ICO territories interested in organizing the 23rd ICO Congress (ICO-23), to be held in 2014.

Usually the congresses are held in August or in early September. ICO prefers that the congresses alternate between the various parts of the world. Highly qualified proposals are encouraged from all territories and all bids will be considered. ICO-22 will be held in Puebla, México, in August 2011. ICO-21 was held in July 2008 in Sydney, Australia. ICO-20 was held in 2005 in Changchun, China, ICO-19 in 2002 in Florence, Italy, ICO-18 in San Francisco, California, in 1999, and ICO-17 in 1996 in Taejon, Korea.

Applicants should complete the "Application for ICO General Meetings", which can be found online at www.ico-optics.org/meetings.html. Applications including the necessary enclosures must be received by the ICO associate secretary, Prof. Gert von Bally, electronically or by post, before 15 October 2010 for consideration by the bureau.

Contacts

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Forthcoming events with ICO participation

Below is a list of events with ICO participation that are coming up. For further information, visit www.ico-optics.org/events.html.

20–24 September
VII Ibero-American Conference on Optics & X Latin-American Meeting on Optics and Applications (RIAO/OPTILAS 2010)
Lima, Peru
Contact: Guillermo Baldwin Olguín, tel 511-626-2000, fax 511-626-2085, gbaldwin@pucp.edu.pe
www.pucp.edu.pe/conferencia/riao-optilas

28–30 September
11th Conference of the International Society of Optics Within Life Sciences (OWLS 11)
Quebec City, Canada
Contact: Brian Wilson, tel +1 416 946 2952, fax +1 416 946 6529, wilson@uhnres.utoronto.ca
www.biophotonicsworld.org/events/79-optics-within-life-sciences-owls-11

17–21 October
Transparent Conductive Materials (TCM 2010)
Crete, Greece
Contact: George Kiriakidis, tel +302810391271, fax +302810391306, kiriakid@iesl.forth.gr
www.tcm2010.org

26–29 October
Annual Meeting of the European Optical Society (EOS AM 2010)
Paris, France
Contact: Silke Kramprich, tel +49 511-2788-117, kramprich@myeos.org
www.myeos.org/eosam2010

26–29 October
ICO/EOS Topical Meeting on Optics & Energy (TOM 7)
Paris, France
Contact: Maria Calvo, tel +34 91-394 4684, mlcalvo@fis.ucm.es
www.myeos.org/events/eosam2010-TOM7

11–15 December
International Conference on Fiber Optics and Photonics (Photonics 2010)
India
Contact: Sunil Khijwania; tel + 91 361-2582716; fax + 91 361-2582749, skhijwania09@gmail.com
www.iitg.ernet.in/photonics2010

31 January – 11 February 2011
ICTP Winter College on Optics in Imaging Science
Trieste, Italy
Contact: ICTP Secretariat, tel +39 040-2240-9932; fax +39 040-2240-7932; smr2132@ictp.it

3–7 May 2011
International Conference on Applications of Optics and Photonics
Braga, Portugal
Contact: Manuel Filipe Pereira da Cunha Martins Costa, tel 00351253 604070/604320; fax 00351253604061, mfcosta@fisica.uminho.pt
www.spidof.pt/AOP

18–20 May 2011
Information Photonics (IP 2011)
Ottawa, Canada
Contact: Pavel Cheben, tel 1-613-9931624, fax 1-613-9907656, pavel.cheben@nrc.ca

Responsibility for the accuracy of this information rests with ICO. President: M L Calvo, Universidad Complutense de Madrid, Departamento de Óptica, Facultad de Ciencias Físicas, Ciudad Universitaria s/n, E 28040 Madrid, Spain; mlcalvo@fis.ucm.es. Associate secretary: Gert von Bally, Centrum für Biomedizinische Optik und Photonik, Universitätsklinikum Münster, Robert-Koch-Straße 45, 48149 Münster, Germany; Ce.BOP@uni-muenster.de.

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