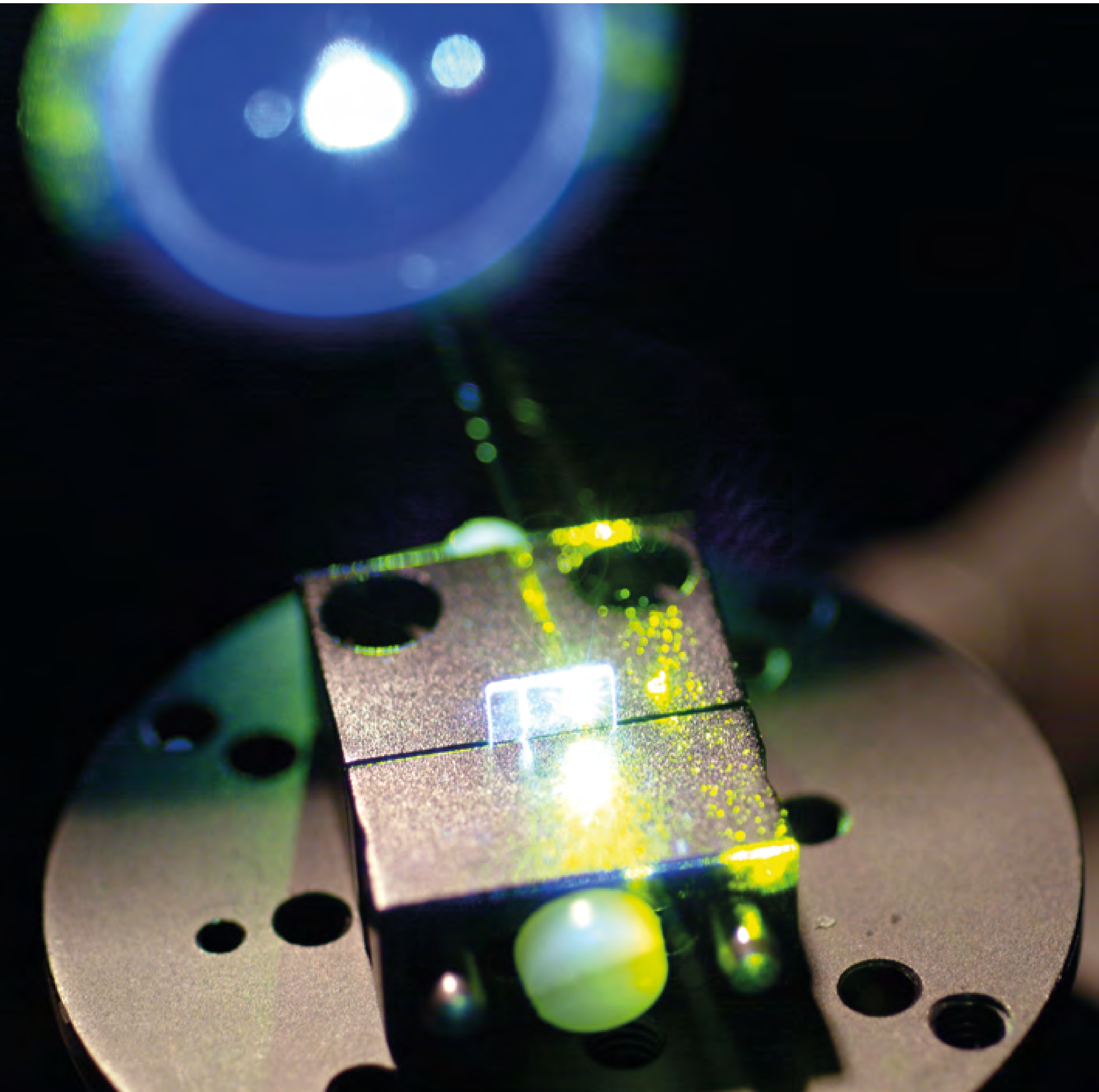
ICFO spotlight

SPRING 2010 | 06



50 years of light

The demonstration of the first operating laser took place at Hughes Research Laboratories some 50 years ago, on May 16, 1960. In the years that immediately followed, lasers were often cited as the perfect example of "a solution looking for a problem." Not anymore today.

Over the last 50 years, lasers have found a virtually unlimited range of problems to solve: laser light has thus become a universal, ubiquitous, and pervasive tool in many areas of science and technology, industrial production, and healthcare. Today, laser light is used for cutting, pasting, welding, polishing, labeling, marking, printing, erasing, pilling, molding, heating, cooling, seeing, communicating, codifying, ranging, inspecting, detecting, sensing, trapping, smelling, diagnosing, healing, and a long list of etceteras. You name it.

Today, industries use laser light to create an endless variety of products and services, as well as millions of jobs. Physicians and clinicians use lasers to save lives and to improve the quality of life of millions of people around the world. Still, the best is yet to come. Laser light is a unique tool not only for its versatility but also for its accuracy, precision, and gentleness. It can be tuned to possess extraordinary qualities, allowing scientists to push the frontiers of our understanding, knowledge, and technologies. Laser light is at the core of the techniques that allow humankind to push the very limits of the ultrafast, the ultrasecure, the ultragentle, the ultracold, the ultrahot, the ultrabroadband, the ultraminimally-invasive, and a long etcetera... You name it.

Nowadays, laser light is used to immobilize single atoms, to record the flying of single excited electrons, to trace single viruses on their way to infecting a cell, to hold single living neurons, and to stretch single strings of DNA. Not very far in the future, we are to witness the development of particle accelerators that will enable us to mimic astrophysical processes on Earth, lab-on-a-chip devices that will seem straight out of science fiction, nanoscopes for ultrasharp imaging, and new tools and equipment for nano-surgery -- all of these based on a clever use of lasers. I cannot even imagine how shortsighted this list will appear 50 years from now. But little doubt it will.

Charles H. Townes, who was born in Greenville, South Carolina in the summer of 1915, is one of the key figures in the discovery and making of lasers. Townes, still an active scientist today at the University of California, Berkeley, always emphasizes the lessons to be learned from the history of the laser discovery: Had a company or government set out to look for brighter light sources, they would probably have hired an expert on light bulbs, Townes has often said. Rather, the laser was invented by people interested in an apparently unrelated field, namely microwave molecular spectroscopy. The path to breakthrough discoveries is rarely the shortest.

Townes also happily voices the view that civilization needs people who know how to do things but that it most needs people who know what to do. I most enthusiastically invite all ICFOnians to honor this extraordinary legacy.

Lluis Torner – ICFO Director

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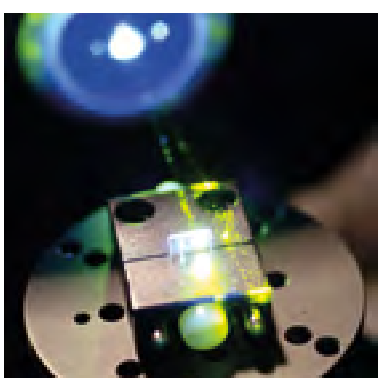

cover

The invention of the laser some 50 years ago has opened the door to an umlimited range of applications in scientific research, medical care, and industrial products and services.

ICFO
Institut de Ciències Fotòniques

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HAPPENINGS

ICFO news

New Networks
ICFO recently founded a new European association for nanophotonics in partnership with the Catalan Institute of Nanotechnology in Barcelona and the European Laboratory for Non-linear Spectroscopy in Florence and La Sapienza University in Rome, Italy. Called Nanophotonics Europe, the network was established with the view to promote training, research, technology transfer, and innovation in nanophotonics. "One of the main challenges that will be addressed by the association is to bridge the gap between the academic and industrial worlds," says Gonçal Badenes, ICFO Staff Scientist and President of Nanophotonics Europe.
In January, ICFO also joined the European Technology Platform (ETP) Nanomedicine. Gathering the European Commission and academic and industrial experts in the field, ETP Nanomedicine was launched in 2006 with the mission to coordinate efforts in nanomedical research across Europe. The platform focuses on nanotechnology-based diagnosis, targeted drug delivery, and regenerative medicine, in particular.

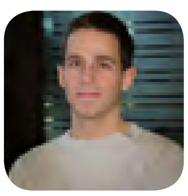
Photonics21
ICFO Director Lluis Torner was elected member of the Photonics21 Board of Stakeholders during its annual meeting in Brussels earlier this year. Photonics21 is a European Technology Platform that was founded in 2005 and today counts more than 1,400 member companies and research institutions in 49 different countries. Photonics21 coordinates training, research, and development activities across Europe with the view to make the continent a leader in the use of photonics in areas as diverse as information and communication, lighting and displays, manufacturing, life sciences, and security. ICFO also contributed to drafting the second Strategic Research Agenda, which Photonics21 recently presented to the European Commission. The agenda, called 'Lighting the Way Ahead', analyzes the potential of photonics to solve the challenges faced by today's society. It also lays out the new vision of Photonics21 for the future of photonics in Europe.

Student Matters
The ICFO Organization and Network of Students (ICONS) now has a newly elected board with Giorgio Volpe as President, Jan Gieseler as Vice-President, Omar Olarte as Secretary, and Rafael Betancur as Treasurer. Launched in 2004, ICONS aims to boost career opportunities for students through the provision of further training and networking opportunities. ICONS is one of four Optical Society of America (OSA) Student Chapters behind the creation of the International OSA Network of Students (IONS), as recently highlighted in an OSA's *Optics & Photonics News* article co-written by IONS Coordinator at ICFO Armand Niederberger.
ICFO has launched a new Erasmus Mundus Joint Doctorate in photonics in collaboration with four other European research institutions. Starting this next academic year, the three-year Europhotonics Doctorate Program offers students the opportunity to carry out a multidisciplinary research project in photonics engineering, nanophotonics, and biophotonics across several partner institutions.

ICFO in the Media
Niek van Hulst, Group Leader at ICFO and Catalan Institution for Research and Advanced Studies (ICREA) Professor, recently appeared on the *Catalunya Vanguardista* news and views website. The article reviews the optical microscopy advances that were made in the recent years for modern science to look at ever-shrinking scales.
The digital science and innovation portal Global Talent recently featured three articles on the unusual optical properties of metamaterials, the development of quantum computers, and the use of photonics to make computers able to 'see' the world around us. ICFO Ph.D. students Giorgio Volpe and Armand Niederberger and former ICFOnian Giovanni Volpe are the authors of the respective articles.
Research on the use of lasers for medical treatment in the lab of ICFO Group Leader and ICREA Professor Romain Quidant also recently appeared on Spanish national TV in the science popularization program *3.14*.

ICFO newcomers

Many people took a new position at ICFO between last December and February 2010...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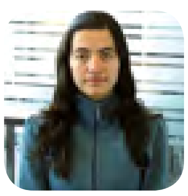
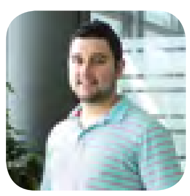
Research Fellow

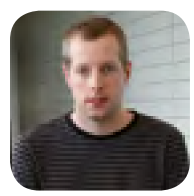

Valeria Rodríguez
Postgraduate Student


Melike Lakadamyali
Junior Group Leader


Francisco Pelayo García
Postgraduate Student


Luis Martínez
Ph.D. Student


Koen Thuijs
Postgraduate Student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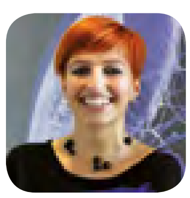
Research Fellow

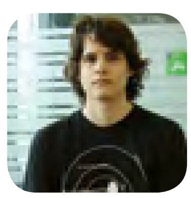

Alejandra Valencia
Outreach

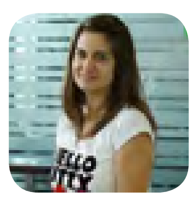

María Bernechea
Research Fellow

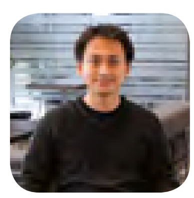

Guillermo Cárdenas
Visiting Scientist


Radek Machulka
Visiting Scientist


Susana Santos
Program Manager L4H

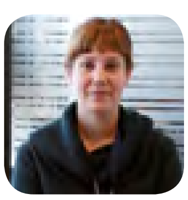

Eliot Hijano
Undergraduate Student


Judith Durá
Postdoctoral Researcher


Xuan Loc Le
Postdoctoral Researcher

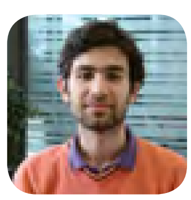

Anthony Leverrier
Postdoctoral Researcher


Jaroslaw Korbicz
Research Fellow


Mireia Casanovas
European Projects Manager


Igor Blanco
Postgraduate Student


Swen Künzel
Postgraduate Student


Attaallah Almasi
Postgraduate Student

welcome to ICFO

ICFO events

Researchers from several institutions and companies in France, Switzerland, and Spain gathered at ICFO on January 13 for the kick-off meeting of SPEDOC, a collaborative project supported by the European Commission for the early detection of cancer using nano-optics, optical manipulation, and microfluidics.

ICFO also hosted at the beginning of February the kick-off meeting of the European Network of Excellence Nanophotonics for Energy Efficiency, which gathers nine different research institutions in Spain, France, Italy, Germany, Turkey, Sweden, and the United Kingdom.

Also in February, ICFO Group Leader and ICREA Professor Niek van Hulst gave senior citizens a guided tour of the nanoworld. The lecture was given as part of a life-long education program run by the Technical University of Catalonia.

LATEST ADVANCES

research highlights

Making Waves
Experimental work on surface waves carried out by ICFO Ph.D. Student Osamu Takayama, Staff Scientist David Artigas, and ICFO Director Lluis Torner was highlighted as one of the major advances achieved in optics in 2009. The team was able to produce and observe for the first time a unique class of surface waves whose existence was predicted back in 1988. The surface waves had up to now eluded experimental observation due to the technical difficulties associated with the very specific conditions needed for their manifestation. Potential applications for the research, which was sponsored by the Fundació Cellex Barcelona, range from sub-wavelength light microscopy and nano-optical tweezing to early medical diagnosis and minimally-invasive therapies. The work appeared in *Optics in 2009*, a special issue *Optics & Photonics News* (OPN) publishes every December to celebrate the latest scientific achievements in the field.

Disorder Creating Order
Laurent Sanchez-Palencia of the Institut d'Optique in Palaiseau, France and ICFO Group Leader and ICREA Professor Maciej Lewenstein recently described in the online edition of Nature Physics their perspectives on disordered systems with controlled disorder. In their review article, the two authors build upon theoretical predictions they made in earlier work regarding the localization of matter waves in ultracold atomic gases and the existence of the so-called disorder-induced order phenomenon.
Sanchez-Palencia and Lewenstein present ultracold atom systems such as Bose-Einstein condensates as an especially suitable playground for the study of disorder-induced order phenomena in condensed-matter physics. "Amazingly, controlled disorder might sometimes induce more order, especially when it happens to compete with other order preventing mechanisms," the two authors write. Sanchez-Palencia and Lewenstein also predict a tide of new applications in the field now that such phenomena have been observed experimentally.

Forbidden Transitions
Nature Materials, Nature Photonics, and the *Physics* website of the American Physical Society (APS) recently highlighted results from ICFO researchers on the free-space excitation of surface plasmon polaritons (SPP). SPP are electromagnetic surface waves with great potential in optoelectronics, metamaterials, imaging, and biosensing. Due to their evanescent nature, SPP normally can not be coupled to propagating light and require a special setup to compensate for the mismatch. Following a groundbreaking approach, the researchers generated SPP on metals with two propagating laser beams. It is not yet "practically viable, but the rationale behind this new method could be applied towards exciting other bound modes in related systems," comments the *Physics* article. The results were published in December 2009 in *Physical Review Letters* by ICFO Group Leaders and ICREA Professors Romain Quidant and Niek van Hulst and ICFO Research Fellow Jan Renger, in collaboration with ICFO Distinguished Invited Professor Lukas Novotny and Stefano Palomba of the University of Rochester in the United States.

New PhD. Graduates
Carsten Schuck obtained a Ph.D. on January 13 for his research on the construction of an ion trap apparatus for the study of distant atomic entanglement, simple quantum network, and controlled atom-photon interaction. The work was supervised by ICFO Group Leader Jürgen Eschner.
Noelia González also graduated on January 15 for characterizing and measuring the spatial shape of photons in a doctoral thesis done under the supervision of ICFO Group Leader Juan P. Torres. The work could lead to a better understanding of storage quantum information.
In February, Agata Chęcińska also obtained a Ph.D. from the University of Warsaw in Poland for her work on noisy quantum channels for qutrit states. Her research was supervised by ICFO Group Leader and ICREA Professor Maciej Lewenstein at ICFO in collaboration with Polish Professors Jerzy Kamiński and the late Krzysztof Wódkiewicz in Warsaw.

business news
by Silvia Carrasco

ICFO Corporate Liaison Day

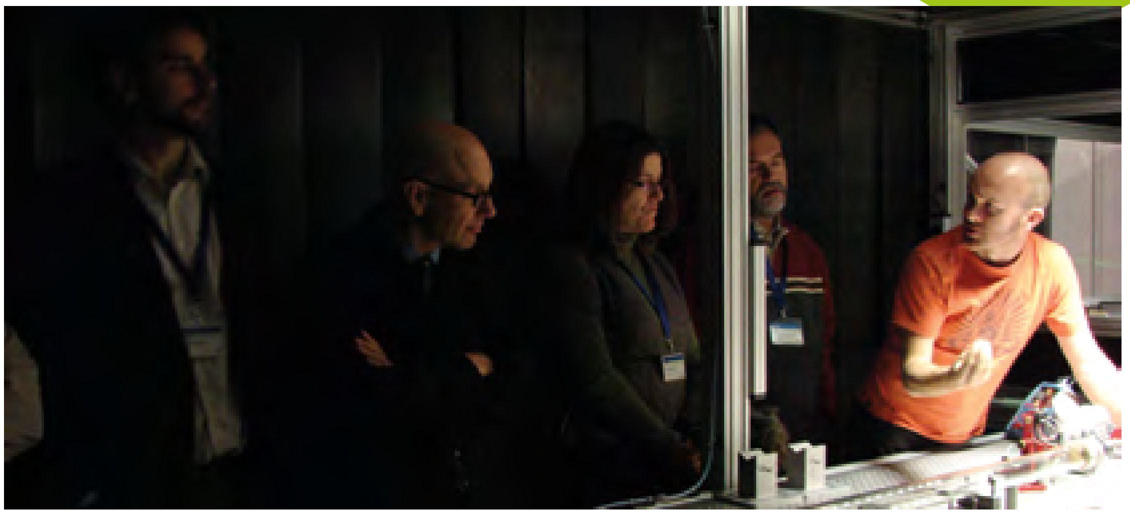
ICFO recently held its first annual Corporate Liaison Day. Industrial partners and members of the Corporate Liaison Program (CLP) came to the Institute for a day of scientific exchange and networking with the ICFO community. The program featured a series of thought-provoking talks at the interface of scientific research and the business enterprise. After warmly welcoming the day's four distinguished guest speakers, ICFO Director Lluis Torner handed over to María J. Yzuel, 2009 President of The International Society for Optics and Photonics (SPIE) and optics professor at the Autonomous University of Barcelona. In her talk, María Yzuel discussed the importance of corporate liaison programs and their value for research centers, scientists and students, and partnering companies.

Michael S. Lebby, President and CEO of the Optoelectronics Industry Development Association (OIDA) in Washington, DC and a prolific inventor in the United States, pursued with a presentation on the role of green photonics in a global market on the verge of an energy and broadband collapse.

Darío Gil, TA to Tze-Chiang Chen, the Vice-President of Science and Technology at IBM Research Division's Thomas J. Watson Research Center in Yorktown Heights, New York took over with a talk reviewing the evolution and the current development strategy of IBM Research and Technology.

Josep Maria Perdigués Armengol, an optical engineer at the European Space Agency (ESA) in Noordwijk, The Netherlands, concluded the session with a presentation on the current and potential applications of photonics in spacecraft projects.

Top: The ICFO Corporate Liaison Day invited industrial partners and other CLP members to come to the Institute for a day of scientific exchange with the ICFO community.
Bottom: CLP members assisted to the demonstration of ongoing research experiments at ICFO.



Following a networking lunch, CLP attendants were invited to take a lab tour with ICFO group leaders Turgut Durduran, Morgan Mitchell, Valerio Pruneri, Jens Biegert, and Romain Quidant. The group leaders explained the objectives of their research programs in medical optics, quantum information with cold atoms and non-classical light, optoelectronics, attoscience and ultrafast optics, and plasmon nano-optics, respectively.

The ICFO CLP Program is designed to foster links between ICFO and a broad range of industries and corporations. Ultimately, the CLP aims to build mutual trust to generate further knowledge and achieve goals of common interest. We warmly invite all small and large companies and industrial corporations using photonics or contemplating doing so in the future to start establishing a long-lasting relationship with ICFO by joining the Program.

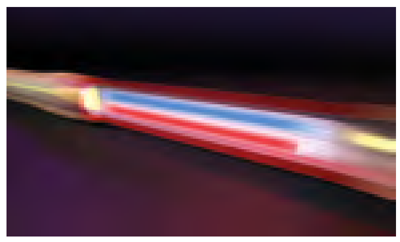
LASER ANNIVERSARY

lasers today and tomorrow

The invention of the laser 50 years ago has had a huge impact on a variety of research fields and on many aspects of our everyday life. As part of LaserFest, a yearlong and worldwide celebration of the wonders brought along by the laser, several Group Leaders at ICFO reflect on the importance of lasers in their lab and beyond.

“Originally nicknamed ‘a solution looking for a problem’, lasers have today become an essential tool in our research in attoscience and ultrafast physics. Our everyday life is governed by the interplay of light and electrons. Indeed, the motion of electrons within matter is able to create or destroy light; it can transmit information and energy; it can transform light into biological energy; it can break molecules apart. Our ambitious aim is to unravel the infinitely small using the fastest, shortest pulses ever generated with lasers. These allow us to take snapshots of electronic motion -- just in the same way as photo reporters use their cameras to take snapshots of sporting events -- so that we may visualize, understand, and ultimately control electronic motion. Lasers are fascinating by themselves, but they also are an invaluable tool for opening the door onto the fascinating microcosm surrounding us.”

Jens Biegert
Attoscience and Ultrafast Optics

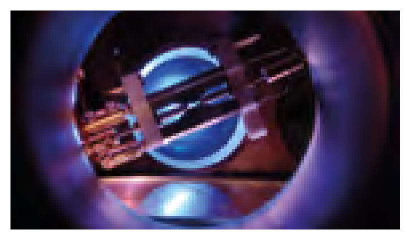


“What I find most fascinating about lasers is the multiple possibilities coherent light (that is, lasers) can offer compared to conventional light. For example, starting with just one color, it is possible to generate several different colors, a conversion process that is being used in my lab to develop Head-Up Displays for car drivers or special photons sources for secure communication. We also take advantage of the unique laser propagation properties in optical fibers to create sensors for the aerospace and the construction industries.”

Valerio Pruneri
Optoelectronics

“While the processes that underlie how a laser works rely on fairly complicated physics-based principles, it is actually possible to use lasers in very straight forward ways. In our lab, we use the light of a laser, which is made up of millions and millions of photons, in order to hold objects that are many times smaller than the width of a human hair. This optical trap allows us to catch single cells and single proteins within a liquid suspension and manipulate them to study how they work. The amazing thing is that the laser, after all the physics and engineering work that has been done to develop this technology, is now being used by us to do the most basic actions of catching and holding, only now with objects the size of a human cell.”

Dmitri Petrov
Optical Tweezers



“In our research, we use lasers as a tool to move or immobilize single atoms, to detect or hide atoms, and to make two different atoms look distinguishable or indistinguishable. We also use lasers to trick single atoms into creating or annihilating single photons.
Part of the fascination I feel for lasers is just how precise they are: in order to excite atoms we need to use lasers with a color that may represent as little as just one billiardth of the whole spectrum.”

Jürgen Eschner
Quantum Optics and Information with Single Atoms and Photons

“One major line of research in our lab focuses on combining laser light with gold nanoparticles to create point-like sources of both light and heat. Such sources have key applications in a variety of scientific fields, ranging from high-density information processing to cancer diagnosis and therapy.”

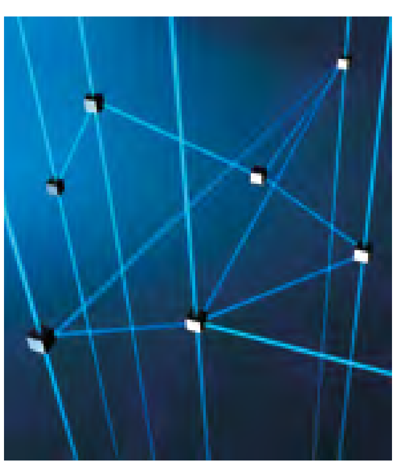
Romain Quidant
Plasmon Nano-Optics

“Lasers have become fundamental workhorses in research, providing us with coherent light sources with well-defined characteristics like tunable colors and ultrafast control for photonics science. Laser sources in our group in particular allow us to work at the diffraction limit and beyond, to look at single molecules and quantum dots, and to address the nanoscale. We use ultrafast broad-band lasers as unique sources for the coherent control of single molecules, nanoantennas, and other nanostructures. We are also trying to push some current technical limits of the laser -- one of our challenges is now to produce nanolasers.”

Niek van Hulst
Molecular Nanophotonics

“For me, a laser is in the first place a tool that makes amazing things happen like the engineering and controlling of matter at the quantum level, in particular. By using lasers, we can trap and cool individual atoms as well as atomic gases; we can study quantum physics with single particles and complex many-body systems. Potential applications are enormous: from quantum computers and quantum memory through quantum communications and quantum internet to quantum precision metrology.”

Maciej Lewenstein
Quantum Optics Theory



“If you watch a football match without knowing the rules and can not see the ball, you will find it extremely difficult to understand the game. Only when you see the ball do you get a chance to understand how it goes.
Biological processes within cells are like football games in which we cannot see the ball. In many ways, lasers have become an effective tool in microscopy, helping us visualize what’s going on within cells and whole organisms with enormous implications for the biomedical field.
I find it fascinating that you can control the properties of laser light, and in particular ultra-short pulsed lasers, in order to visualize, with high resolution, sections of living cells and organisms deep inside them without disturbing them at all. One other thing that fascinates me is that the use of lasers in microscopy is continuously evolving. Every day, new ways of using lasers are being reported and new information is getting unveiled at the cellular and even molecular level.”

Pablo Loza-Alvarez
Ultrafast Imaging and Nonlinear Microscopy

LASER ANNIVERSARY

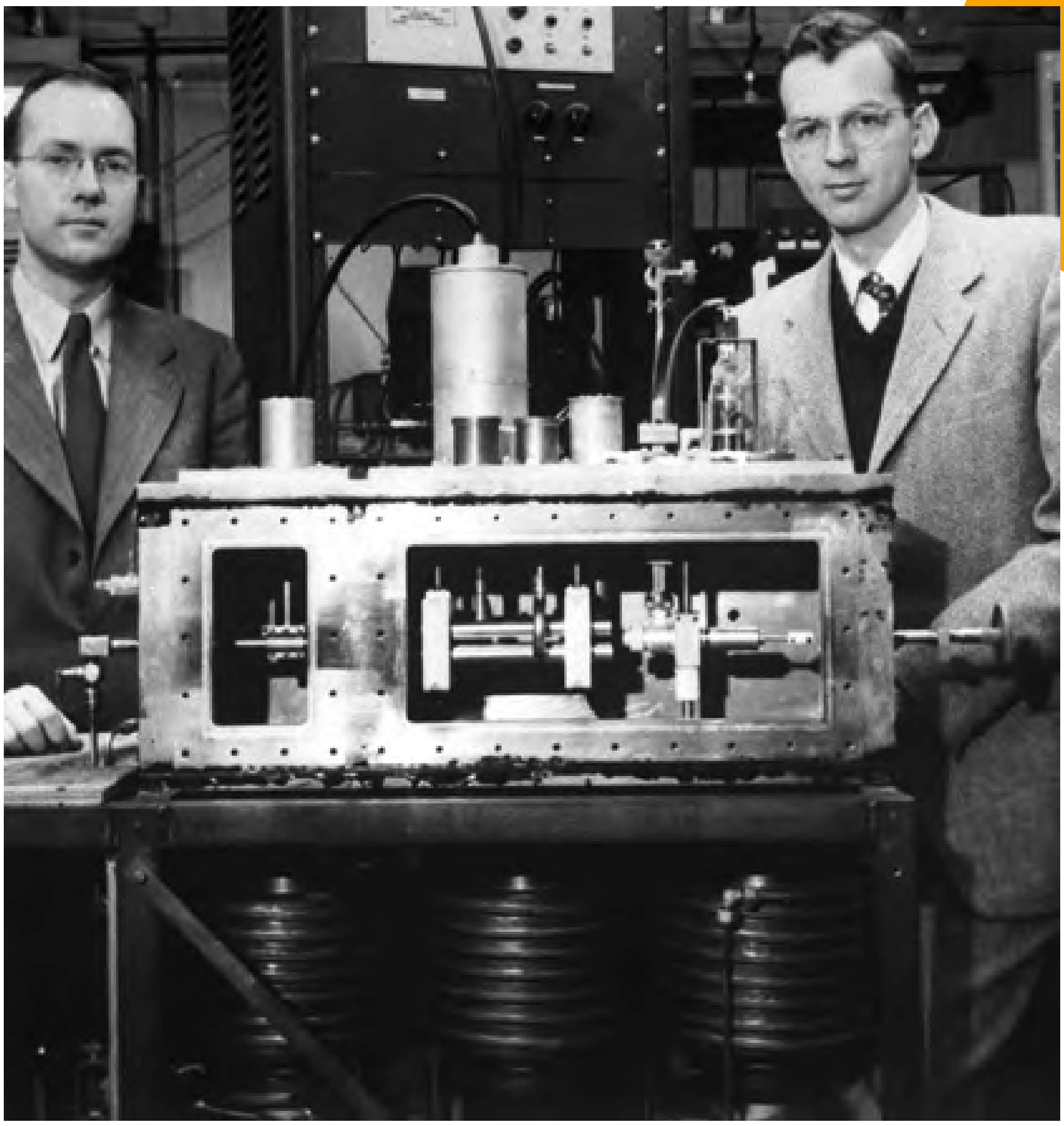
Celebrating 50 Years of Lasers

by Alejandra Valencia

The year is 1960 and the place is Hughes Research Laboratories in Malibu, California. Right there and then, a 32-year-old man called Theodore H. Maiman won the race for the first operating laser. This "solution looking for a problem", as Maiman's coworker Irnee D´Haenens then defined it, has over the years become one of those scientific discoveries with a tremendous impact on our everyday life. Today, lasers are ubiquitous. From our printers and CD players to medical treatments and security systems, the characteristics of laser light have shaped the lifestyle of the XXI century.

The word 'laser' is an acronym standing for 'Light Amplification by Stimulated Emission of Radiation.' These words not only sound like a nice rhyme but also describe the physics behind the laser's working principles. 'Stimulated emission of radiation' occurs when a photon (the elementary particle of light) hits an atom in an excited state and stimulates it to return to its basal energy level through the emission of another, identical photon. Since atoms, as we find them in nature, are normally not in an excited state, the concept of stimulated emission may seem, at first, somewhat irrelevant. However, under suitable conditions, it is possible to have a system where the majority of atoms actually are in a higher-energy excited state -- a physical phenomenon known as population inversion. In such a setting, some of the excited atoms start releasing photons that will likely hit some other excited atoms, stimulating them to emit yet more photons. These new photons will in turn hit other excited atoms, triggering the release of an avalanche of photons that corresponds to the 'light amplification' part of the laser acronym.

The concept of stimulated emission was first introduced by Albert Einstein in 1916. In 1924, physics professor at the California Institute of Technology in Pasadena Richard Tolman discussed the possibility of using stimulated emission as an amplification process. The idea of implementing an actual working device based on this principle had however not yet been formulated. History tells us that it was not until April 26, 1951 that a 35-year-old physics professor named Charles H. Townes came up with the idea while sitting on a bench in Franklin Park in Washington D.C.



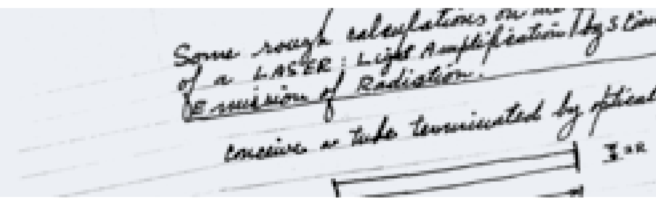
Top: **Theodore H. Maiman of Hughes Aircraft Company showing a cube of synthetic ruby crystal, the material at the heart of the first laser**

Left: **Charles H. Townes (left), winner of the 1964 Nobel Prize for Physics, and associate James P. Gordon in 1955 with the first maser**

A few years later, in 1954, Townes and his team at Columbia University in the City of New York were able to build the first device capable of generating radiation by amplification of stimulated emission. The generated radiation was in the microwave regime; therefore, they called it a 'maser', the acronym for 'Microwaves Amplification by Stimulated Emission of Radiation'. The maser is in fact the precursor of the laser. They are both based on stimulated emission but amplify radiation at different wavelengths. So while a maser amplifies and produces low-energy radiation (called microwaves, hence the 'm'), a laser generates a beam of higher energy corresponding to light (hence the 'l').

Going from the maser to the laser may seem simple: just use the maser principles, but at lower wavelengths. The road leading to the invention of the laser was all but easy however. By summer 1957, Townes had started working as a consultant for Bell Labs in New Jersey where he worked closely with his brother-in-law Arthur Schawlow. In December 1958, the two of them published a paper in Physical Review describing the basic principles of what they called an 'optical maser': a maser operating in the visible regime. Nonetheless, a prototype for a laser device has yet to be developed. Many corporations, universities, big industrial research organizations, and individual scientists entered a scientific race to become the first to actually create the device.

One scientist among them was Gordon Gould, at the time a Ph.D. student at Columbia University. Gould formulated some ideas on how to create what he called, in 1959, 'a laser.' His annotations about lasers and a list of possible uses for such a device date back to November 1957 and can be found in a notebook Gould got notarized in a local candy store. The

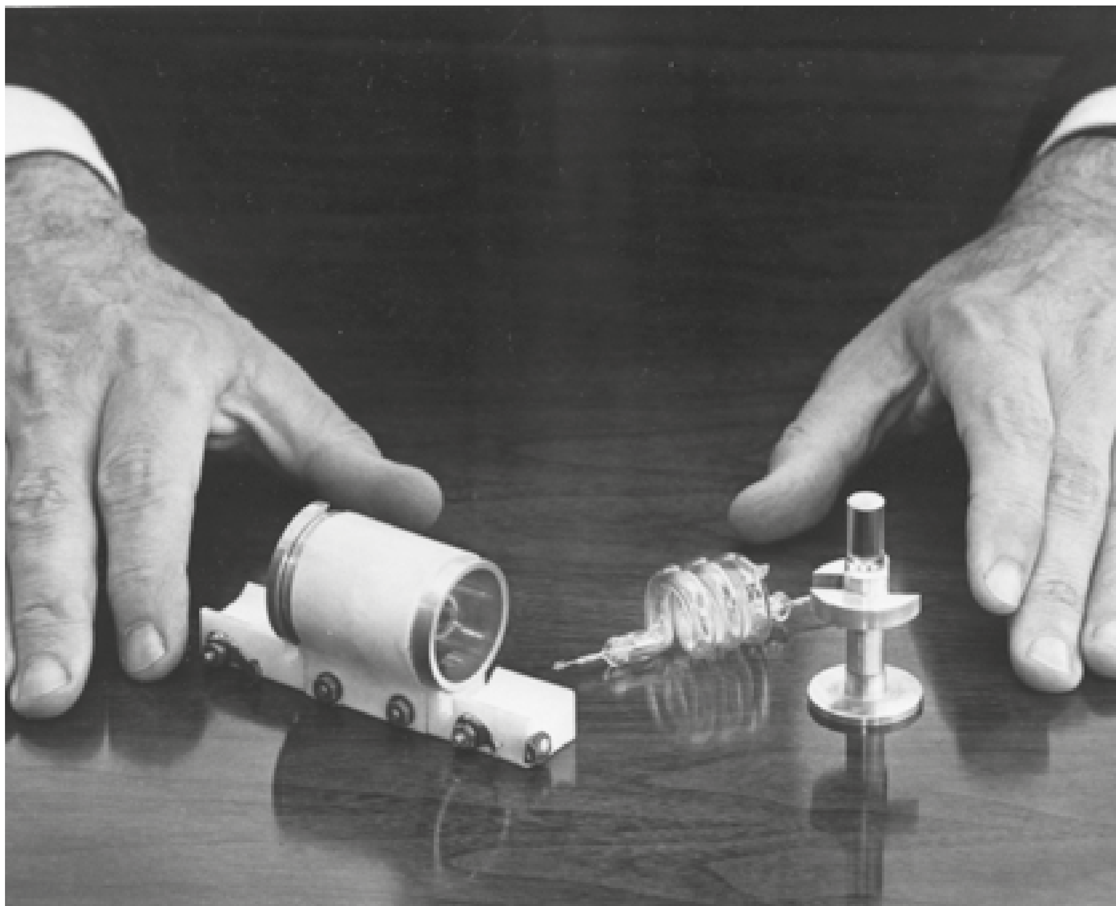


notebook was to be used as evidence in the first of many legal fights over the ownership of several patents related to the discovery of the laser, some of which he won.

By the end of the 1950's, the interest in developing a working laser device had grown to the point that the first conference on quantum electronics was organized. It was held at the Schawanga Lodge in the state of New York in September 1959. Among the conference attendees was experimental physicist Theodore Maiman of Hughes Research Laboratories. Maiman, who was working on ruby masers at the time, didn't take for face value Schawlow's opinion back then that using pink ruby would not work for laser emission. Maiman is said to have left Schawanga Lodge eager to further study the properties of ruby and the possibility to build a laser with it.

Over the few months that followed, Maiman did various measurements on ruby that indicated its suitability for laser generation. The next technical problem to solve for Maiman was how to generate enough energy to excite the atoms in the 1.5 cm-long ruby crystal he was using to obtain population inversion. The solution came from an amateur photographer who was working with him at the time and gave him the brilliant idea of using a photographic lamp. On May 16, 1960, Maiman and his coworkers fired the lamp, which excited the chromium atoms in the ruby and produced stimulated emission of light. Maiman had polished the edges of the ruby rod in order to create a cavity where the produced light could bounce back and forth, eventually escaping as a concentrated beam. A red glow illuminated the room. The laser was born.

A brief description of Maiman's laser was published in *Nature* the same year . Maiman's model was simple and easy to reproduce. This helped convince even the most skeptical scientists, who were able to reproduce a laser in their own labs only weeks after Maiman's achievement. A few years later, in 1964, Townes and Russian scientists Nicolay Basov and Aleksandr Prokhorov were recognized for their fundamental work leading to the construction of devices based on the maser-laser principle with a shared Nobel Prize.



Maiman's first laser, disassembled

Initially, devices able to produce radiation at an optical wavelength did not have any obvious applications. The laser nonetheless soon found a lot of problems to solve. In 1961, a ruby laser was used for the first time to destroy a retinal tumor in humans. In July 1969, following the Apollo 11 mission to the moon, a laser beam was shone from and back to the Earth, allowing researchers to get a measurement of the Earth-moon distance within centimeter precision.

Nowadays, lasers are used in all kinds of areas: from fundamental research to applications in communication, medicine, and entertainment. Today, it is almost impossible to find a consumer product that has not been touched by a laser at some point during its production. Over the years, the laser has become an excellent example of how fundamental research can lead to technological innovations and generate economic growth.

sources and further reading

- 'Beam: The Race to Make the Laser', by Jeff Hecht. Oxford University Press (2005)
- 'How the laser happened: Adventures of a Scientist', by Charles H. Townes. Oxford University Press (1999)
- 'Obituary: Theodore H. Maiman (1927-2007)', by Charles H. Townes. *Nature* **447**, 654 (2007)
- 'Stimulated Optical Radiation in Ruby', by T. H. Maiman. *Nature* **187**, 493-494 (1960)
- 'Infrared and Optical Masers', A.L. Shawlow and C.H. Townes. *Physical Review*, **112**, 140, 1940–1949 (1958)

LaserFest

In 2010, the American Physical Society (APS), the Optical Society of America (OSA), the international society for advancing light-based research SPIE, and the IEEE Photonics Society together launched LaserFest in order to commemorate the 50th anniversary of the first working laser. LaserFest is a yearlong celebration featuring laser demonstrations in schools, educational videos, public lectures, and blog and newspaper coverage organized by local organizations and communities around the world. As the Executive Director of the Stanford Photonics Research Center and 2009 OSA President writes on the LaserFest website, "One goal of LaserFest is honoring the original laser pioneers, both scientists and entrepreneurs. A second goal is highlighting for the general public the laser as one of the best examples of innovation; basic scientific research translating into technology resulting in great economic benefit. Yet a third goal is inspiring young people to pursue careers in optical science and engineering." ICFO is taking part in the LaserFest initiative with a wide range of outreach activities in the pipeline. These include talks about the laser and its applications to non-specialist audiences and school students, the production of informative material, the organization of visits to ICFO, and the demonstration of lab experiments. We invite you all to participate in this yearlong celebration and join ICFO in its outreach activities.

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THE LAST WORD

high profile

Charles H. Townes is Professor Emeritus of Physics at the University of California, Berkeley. In 1964, Professor Charles H. Townes became a Nobel Laureate in Physics "for fundamental work in the field of quantum electronics, which has led to the construction of oscillators and amplifiers based on the maser-laser principle."

Q: What sparked your original interest in physics?
A: I like to understand how the universe works. That's fascinating to me. Even as a child, I lived on a small farm and I explored everything. I identified the plants and the animals and the birds and the stars.

Q: What led you to build the first maser?
A: During World War II, I was asked to build a radar at a particular wavelength and it turned out that wavelength was absorbed by water in the atmosphere, which was a disappointment. It meant that radar at that wavelength wouldn't work. But I studied the absorption, and I recognized that we could understand the water molecule and a lot of other molecules.

And so, after World War II, I decided to do physics on molecules with microwaves. I also wanted to go down into the infrared region to study molecules still more, and I kept working on possible ways of doing that. I was even made chairman of a national committee to try to find out how to make oscillators at shorter wavelengths and we didn't find any ideas. The last meeting, when we would have to write our report [on 26 April 1951], I woke up early in the morning worrying about it, and I went out to sit on a park bench. I thought, well of course molecules and atoms make short wavelengths, but we can't use them to amplify. And then I suddenly recognized: 'Oh, wait a minute. If we make molecules and atoms in a special state, then I can amplify. Oh boy, I have the idea.' And so then I persuaded a very good graduate student, [J.P.] Gordon, to try to make this work -- first in the microwave region. It took about 2 years to build one, but we succeeded.

Q: How did you go from there to working on the laser?
A: Nobody was interested in the maser, which is what we named the new type of oscillator, until we had one working. And then, everybody got interested. They were all working in the microwave region but I wanted to get a shorter wavelength; that was my primary purpose. So I sat down with a paper and pencil and I recognized 'hey, we can go right on down to optical waves.' So that was the origin of the laser. Arthur Schawlow worked with me on it and we decided to publish a theoretical description first because we knew there'd be a lot of interest and competition in actually making one.

Q: What applications of the laser discovery do you find most fascinating nowadays?
A: It never occurred to me that lasers would be useful for medicine but they are in fact very useful. I'm also pleased to see how much lasers are used for many industrial applications, and how much good science is produced. In addition to the Nobel Prize I and the Russians received, there have been 12 Nobel Prize winners whose work has depended on use of the maser or laser. And I'm sure there will be more.

Q: What do you find most surprising in the use of lasers today?
A: The wide variety and cheapness of lasers is impressive and surprising. Also, the fact that lasers are being arranged to produce more peak power than any other present sources is surprising and impressive. There will continue to be many uses of lasers, including many new ones we don't now envisage.

Q: Any advice you would like to share with young scientists?
A: I would suggest they study the things they find most interesting and especially be devoted to understanding new things. Be willing to be different. When we were working on the maser, two very famous physicists, each with a Nobel Prize, both came in my laboratory and said, 'Look, it's not going to work. You should stop.' So I said, 'no, I think it has a chance of working. I am going to continue.' They left my laboratory, annoyed. I was about 36 years old.

Q: What made you so confident?
A: My parents taught me to always follow the things that you think are right. Don't just do what other people tell you to do. Be willing to take some risks.

sudoku

easy

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medium

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difficult

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			4		8			
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		1	3		2	7		
5	3						1	9
		8	6		1	4		
2	7						9	3
			2		4			
		5				8		

very difficult

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		2	7		8	4		5
		8		9			6	
	3				6			
				2		8		1

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