United Nations
Educational, Scientific and
Cultural Organization

INTERNATIONAL
YEAR OF LIGHT
2015

INSPIRED BY LIGHT

Reflections from the International Year of Light 2015

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International Year of Light 2015

Produced in January 2016 by SPIE, the European Physical Society (EPS), and
The Abdus Salam International Centre for Theoretical Physics (ICTP) to
commemorate the International Year of Light and Light-based Technologies 2015.
Website: http://light2015.org

SPIE.
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Bellingham, Washington 98227-0010 USA
Website: http://spie.org

ACKNOWLEDGMENTS

Cover images: iStock/Mona Makela.

The IYL 2015 daily blog was curated by Jorge Rivero González, European Physical Society.
Website: http://light2015blog.org

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55th Anniversary of the Laser's Invention

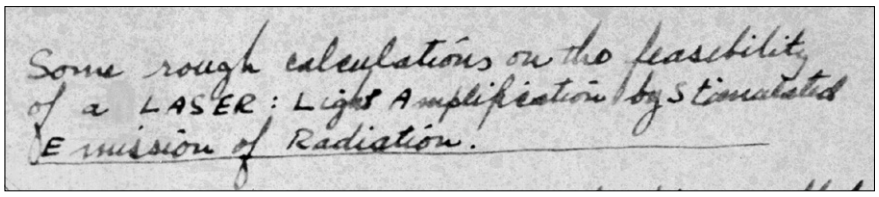
Augusto Beléndez, University of Alicante, Spain

Fifty five years ago the laser, one of the most important and versatile scientific instruments of all time, was invented. It was on 16 May 1960 that the North American physicist and engineer, Theodore Maiman, obtained the first laser emission.

This date is therefore of great importance not only for those of us who carry out research in the field of optics and other scientific fields, but also for the general public who use laser devices in their daily lives. CD, DVD and Blu-ray players, laser printers, barcode readers, and fibre optic communication systems that connect to the worldwide web and Internet are just a few of the many examples of laser applications in our daily life. Lasers also have a range of important biomedical applications; for example, they are used to correct myopia, treat certain tumours, and even whiten teeth, not to mention the beauty clinics that continually bombard us with advertisements for laser depilation, which has become so popular nowadays. However, the laser is of great importance not only due to its numerous scientific and commercial applications or the fact that it is the essential tool in various state-of-the-art technologies but also because it was a key factor in the boom experienced by optics in the second half of the last century. Around 1950 optics was considered by many to be a scientific discipline with a great past but not much of a future. At that time, the most prestigious journals were full of scientific papers from other branches of physics. However, this situation changed dramatically thanks to the laser, which led to a vigorous development of optics. It is indisputable that the laser triggered a spectacular reactivation in numerous areas of optics and gave rise to others such as optoelectronics, nonlinear optics, and optical communications.

What is a laser?

A laser is a device capable of generating a light beam of a much greater intensity than that emitted by any other type of light source. Moreover, it has the property of coherence, which ordinary light beams usually lack. The angular dispersion of a laser beam is also much smaller, so when a laser ray is emitted and dispersed by the surrounding dust particles, it is seen as a narrow, straight light beam. But let us leave to one side the specialized technical points, more suitable to other types of publications, and concentrate on aspects of the invention of the laser that are no less important and no doubt of greater interest to the general public. The word laser is actually an acronym for Light Amplification by Stimulated Emission of Radiation and was coined in 1957 by the American physicist Gordon Gould (1920–2005), working for the private company Technical Research Group (TGR), who changed the "M" of Maser to the "L" of Laser.


Some rough calculations on the feasibility of a LASER: Light Amplification by Stimulated Emission of Radiation.

First page of Gordon Gould's 1957 lab notebook where he defines the term 'LASER.' CREDIT: AIP Emilio Segrè Visual Archives.

In the image above, the phrase "some rough calculations on the feasibility of a LASER: Light Amplification by Stimulated Emission of Radiation" may be seen from Gordon Gould's manuscript, 1957.

The origins of the development of the laser may be found in a 1916 paper by Albert Einstein on stimulated emission of radiation: "Strahlungs-emission und -absorption nach der Quantentheorie" (Emission and ab-

sorption of radiation in quantum theory). But it was an article published on 15 December 1958 by two physicists, Charles Townes (who died on 27 January 2015 at the age of 99) and Arthur Schawlow titled "Infrared and optical Masers," which laid the theoretical bases enabling Maiman to build the first laser at the Hughes Research Laboratories (HRL) in Malibu, California in 1960. Maiman used as the gain medium a synthetic ruby crystal rod 1 cm long with mirrors on both ends and so created the first-ever active optical resonator. It is probably not general knowledge that Hughes Research Laboratories was a private research company founded in 1948 by Howard Hughes, eccentric multimillionaire, aviator, self-taught engineer, Hollywood producer, and entrepreneur played by Leonardo DiCaprio in the 2004 film Aviator, directed by Martin Scorsese. The executives of the Hughes Research Laboratories gave Maiman a deadline of nine months, $50,000 dollars, and an assistant to obtain the first laser emission. Maiman was going to use a movie projector lamp to optically excite the gain medium, but it was his assistant, Irnee D'Haenes, who had the idea of illuminating the ruby crystal with a photographic flash.

When he obtained the first laser emission, Maiman submitted a short article to the prestigious physics journal *Physical Review.* However, the article was rejected by the editors who said that the journal had a backlog of articles on masers—antecedent of the laser in the microwave region—and so had decided not to accept any more articles on this topic since they did not merit prompt publication. Maiman then sent his article to the prestigious British journal Nature, which is even more particular than Physical Review. However, it was accepted for publication and saw the light (excuse the pun) on 6 August 1960 in the section Letters to Nature under the title "Stimulated optical radiation in ruby," with Maiman as its sole author. This article, which had barely 300 words and took up the space of just over a column, may well be the shortest specialized article on such an important scientific development ever published. In a book published to celebrate the centenary of the journal Nature, Townes described Maiman's article as "the most important per word of any of the wonderful papers" that this prestigious journal had published in its hundred years of existence. After Maiman's article was officially accepted by *Nature*, Hughes Laboratories announced that the first working laser had been built in their company and called a press conference in Manhattan, New York on 7 July 1960.

In a very short time the laser stopped being a simple curiosity and became an almost unending source of new scientific advances and technological developments of great significance. In fact, the first commercial laser came on the market barely a year later in 1961. In the same year the first He-Ne lasers, probably the most well-known and widely used lasers ever since, were commercialized. In these early years between 1960 and 1970 none of the researchers working on developing the laser—the majority in laboratories of private companies such as those of Hughes, IBM, General Electric or Bell—could have imagined to what extent lasers would transform not only science and technology but also our daily life over the subsequent 55 years.

Augusto Beléndez is a full professor of applied physics, leader of the Group of Holography and Optical Processing, and Director of the University Institute of Physics Applied to Sciences and Technologies at the University of Alicante, Spain. His main interests are in holography, holographic recording materials, holographic optical elements, optical storage, and teaching physics and engineering; he is also actively involved in public outreach.

Charles H. Townes. CREDIT: Roy Kaltschmidt.

Arthur Leonard Schwalow. CREDIT: Wikipedia.

Theodore Maiman (1927–2007), winner of the Wolf Foundation Prize in Physics, 1983. CREDIT: AIP Emilio Segrè Visual Archives.