



Il Colle di  
Galileo

# The INO-CNR Annual Symposium

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Organizers: The National Institute of Optics INO - CNR

**Abstract.** The academic world met in Arcetri with representatives from the spheres of politics and industry on the occasion of the INO-CNR Annual Symposium to discuss the role of Optics in our society, its prospects and future opportunities.

**Keywords.** Optics, light, vision, sources, aerospace, environment, cultural heritage, energy, health, security, spectroscopy, interferometry, microscopy, metrology, quantum optics, systems and sensors, quantum gases, ultracold atoms.

The INO Annual Symposium is the first symposium organized by the National Institute of Optics of the National Research Council (INO-CNR) to celebrate Optics. This initiative, part of the week of events entitled “New Research Horizons in Arcetri”, was organized on the Arcetri hill on March 13<sup>th</sup> and 14<sup>th</sup> 2013.

But what is Optics today? The Merriam-Webster, an Encyclopaedia Britannica Dictionary, defines Optics as “a science that deals with the genesis and propagation of light, the changes that it undergoes and produces, and other phenomena closely associated with it”. This is the traditional definition, but according to the INO-CNR researchers, Optics today is much more than this. The INO-CNR vision is the same as that of the Optical Society of America (OSA): the entire World depends on Optics. From telecommunications to medical imaging, to sustainable energy solutions, optics plays a critical role in many of the applications that drive the modern world.

This new approach to Optics prompted the INO-CNR to organize an event aimed to update the scientific community about the Institute highlights, and also to discuss the fundamental role that Optics plays in our life and its new and unexpected fields of application.

The fact that something has changed became very clear upon entering the location of the event, the Department of Physics and Astronomy in Arcetri, named after “Antonio Garbasso”, it was completely covered in posters prepared by young

INO-CNR researchers to present the different fields of investigation of the Institute: quantum optics, nonlinear and high-intensity optics, optical systems and sensors, interferometry and microscopy, quantum gases and ultracold atoms, micro and nano-optics, spectroscopy and metrology, sources and the science of vision.

All these different researches offer technological solutions in various fields of application, such as Aerospace, Environment, Artwork diagnostics, Energy, Health and Security. In other words, advanced research in Optics contributes to many different aspects of the life of each one of us.

The numbers of the INO Annual Symposium confirm the importance of these topics: 65 posters, 140 participants, 40 speakers, 20 hours of talks, 1 Nobel Laureate guest.

The program alternated invited speaker lectures with talks by young INO-CNR researchers, the meeting of the CNR President Luigi Nicolais with the Institute staff, and the round table on hot topics in Optics.

Following the introduction by Massimo Inguscio, Director of the CNR Department of Physical Sciences and Technology of Matter (DSFTM), and by Paolo De Natale, Director of the INO-CNR, the Opening lecture was made by Theodor W. Hänsch, who was awarded the Nobel Prize in Physics in 2005 for his “contribution to the development of laser-based precision spectroscopy, including the optical frequency comb technique”.

The collaboration between Theodor W. Hänsch and INO is longstanding, having begun in the INO laboratories at the European Laboratory for Non-Linear Spectroscopy (LENS) with the INO researcher Marco Bellini. The frequency comb is nothing more than the broad spectrum produced by a femtosecond laser (a femtosecond corresponds to the duration of a millionth of a billionth of a second) and consists of millions of perfectly equidistant spectral lines. During his talk in Arcetri, titled “Laser Frequency Combs: Applications from the Atomic to the Cosmic Scale”, the Nobel Prize winner underlined the importance of this research in different fields of application: from high-precision spectroscopy which makes it possible to measure sub-nuclear properties, such as the radius of the proton, to the definition of time through the identification of new ultra-stable oscillators that will allow us, among other things, to develop new high-speed telecommunication tools, from the creation of even more reliable instruments for satellite navigation to the measurement of the Earth’s gravitational field with an incredible degree of precision. The prospects are to extend the frequency comb towards the UV and THz region, the latter being the part of the spectrum where the absorption lines of all molecules of biological interest can be observed.

The second session of the symposium was opened by the tutorial lecture by Federico Capasso, Harvard University, with the title “The impact of Quantum Cascade lasers on Science and Technology”. Thanks to the exploitation of inter-subband transitions, quantum cascade lasers (QCLs) have extended the spectrum covered by semiconductor lasers to the mid- and far-infrared, two spectral regions

of great interest for sensing. The peculiar structure of QCLs makes it possible to tailor the emission wavelength and obtain up to several Watts of power from a compact laser source. In the mid-infrared QCLs are nowadays commercial devices, exploited in e.g. high-sensitivity and high-resolution spectrometers or in-situ trace-gas detection, while ongoing research is focused on advanced targets, such as beam shape engineering and generation of broad-band frequency combs. In the attractive far-infrared (i.e. THz) range QCLs still operate only at cryogenic temperature (below 200 K). The efforts of researchers are obviously addressed to overcoming this major limitation, but also to developing practical QCL based THz sensing systems, namely for imaging and spectroscopy.

Programmed for the second day of the INO-CNR symposium was the visit of the CNR President Luigi Nicolais, who came to Arcetri to meet the Institute staff. The President, introduced by Massimo Inguscio, opened his talk underlining the beauty of the visit in Arcetri, starting from Galileo Galilei's house, to the INO headquarters, and he also focused on the importance of the CNR being part of a unique research system in the country in order to achieve the critical mass for national growth (see Fig. 1).

The CNR President opened the round table on the perspectives of Optics and Photonics in Italy and all over the world. How to overcome the crisis through innovation? Is Optics a field in which to invest in the future? Will technological development bring new employment? What is the role of Italy with respect to foreign



Fig. 1. The INO Annual Symposium participants with the CNR President Luigi Nicolais.

countries on Optics and Photonics research topics? The round table was organized so that representatives from the academic world and those of business and politics could compare notes and try to find answers to these and to other questions. Guests included Marco Masi (Tuscan Regional Authority), Marco Ciatti (Superintendent of the Opificio delle Pietre Dure), Alberto Tesi (Vice-Chancellor of the University of Florence), Filippo Mannucci (Director of the Astronomical Observatory in Arcetri), Sesto Viticoli (AIRI), Filippo Levi (INRIM) and Riccardo Pozzo (Director of the CNR Department for Human and Social Sciences), Elisabeth Giacobino (CNRS), and the moderator was Paolo De Natale (Director of the INO-CNR). “This event represents a special occasion to welcome to Arcetri the protagonists of pioneering research in Optics together with young researchers, following the long tradition of this place,” Paolo De Natale said, “and to share opinions with professionals from industry and politics in order to find common ground for development”.

Many opinions and contributions were made by the institutions to the numerous questions, while there was consensus on the view: Optics is already part of technological and scientific progress and is a key factor in industrial success, world growth, and the improvement of the quality of life.

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