30° anniversario dell'IEEE-LEOS

Per la celebrazione del trentesimo anniversario dell'IEEE-LEOS (Lasers and Electro-Optics Society), il Capitolo italiano del LEOS organizza un evento commemorativo su:

Trent'anni di Elettro-Ottica in Italia: tappe fondamentali e prospettive

30 gennaio 2008
14:00- 18:30
Sala del Chiostro – Facoltà di Ingegneria
Sapienza Università di Roma, Via Eudossiana 18

Presidente - Prof. Stefano Riva Sanseverino (Università di Palermo)
Moderatore - Dr. Tiziana Tambosso (Presidente IEEE-LEOS Italian Chapter)

Relatori
Prof. Fortunato Tito Arecchi (Università di Firenze)
Prof. Francesco De Martini (Sapienza Università di Roma)
Prof. Orazio Svelto (Politecnico di Milano)

Comitato Organizzatore
Prof. Gaetano Assanto (Università Roma Tre),
Prof. Antonio d'Alessandro (Sapienza Università di Roma)

Programma

14:00-14:15 Saluto del Vice-Presidente dell'Ateneo della Scienza e della Tecnologia di Sapienza Università - Prof. P. Lampariello

14:15-14:30 Introduzione di IEEE-LEOS - Dr. T.Tambosso

14:30-14:45 Presentatione dell'evento - Prof. S. Riva Sanseverino

14:45-15:30 Prof. Fortunato Tito Arecchi
"Tappe fondamentali dello sviluppo dell'ottica in Italia"
"I laser: coerenza, caos, complessità e creatività"

15:30-16:15 Prof. Francesco De Martini
"Tappe fondamentali dello sviluppo dell'ottica quantistica in Italia"
"L'ottica quantistica moderna nella interpretazione dei fondamenti della fisica e dell'informazione quantistica"

16:15-17:00 Prof. Orazio Svelto:
"Tappe fondamentali dello sviluppo dei laser in Italia"
"Laser ad impulsi ultracorti: dai picosecondi agli attosecondi"

17:00-17:30 Discussione e conclusioni

17:30 - 18:30 Rinfresco

L'evento è sponsorizzato da:

Facoltà di Ingegneria Sapienza Università di Roma

Centro per la Ricerca Elettronica in Sicilia

Laboratorio di Ottica non-lineare e Optoelettronica Università Roma Tre

Di seguito sono riportati i sommari delle presentazioni e brevi biografie dei relatori.

Abstracts and Biographies

Prof. F. T. Arecchi (Univ. of Firenze): *"The laser: coherence, chaos, complexity and creativity"*

Abstract

Up to 1960 in order to have a coherent source of light it was necessary to filter out a noisy regular lamp. Instead, the laser realizes the dream of shining a vacuum state of the electromagnetic field with a classical antenna, thus inducing a coherent state as a translated version of the vacuum state ,with a minimum quantum uncertainty.

As a fact, the laser reaches its coherent state through a threshold transition ,starting from a regular incoherent source. Accurate photon statistics measurements proved the coherence quality of the laser as well the threshold transition phenomena ,both in stationary and transient situations.

The threshold is the first of a chain of dynamical bifurcations; in the 1980's the successive bifurcations leading to deterministic chaos were explored. Among the chaotic scenarios, the so called HC(Heteroclinic chaos), consisting of trains of equal spikes with erratic interspike separation, was explored in CO2 and in diode lasers with feedback. It looks as the best implementation of a time code: indeed, networks of coupled HC systems may reach a state of collective synchronization lasting for a finite time, in presence of a suitable external input. This opens powerful analogies with the feature binding phenomenon characterizing neuron organization in a perceptual task.

Thus ,synchronization of a chain of chaotic lasers is a promising tool of a physics of cognition.

Exploration of a complex situation would require a very large amount of time. In cognitive tasks facing a complex scenario, our strategy consists in converging to a decision within a finite short time . Any conscious perception (we define conscious as that eliciting a decision) requires 300 msec, whereas the loss of information in a chaotic train of neural spikes takes a few msec.

The interaction of a bottom-up signal (external stimulus) with a top-down change of the control parameters (induced by the semantic memory) leads to a collective synchronization lasting 300 msec: this is the indicator of a conscious perception. The operation is a control of chaos, and it has an optimality ; if it lasts less than 300msec, no decisions emerge, if it lasts much longer, there is no room for sequential cognitive tasks. We call creativity this optimal control of neuronal chaos.

Biography

Present positions: Chair of Physics, University of Firenze
and Scientific Associate of Istituto Nazionale di Ottica Applicata (INOA)
Official address: Dip. di Fisica - Università di Firenze and INOA, Firenze (Italy)
Tel.: +39-055-23081 Fax: +39-055-2337755, E-mail: tito.arecchi@inoa.it
Homepage: www.inoa.it/home/arecchi

Date and place of birth: 11/12/1933, Reggio Calabria, Italy
Education: 1957: PhD in Electrical Engineering at Politecnico di Milano

Curricular activity

1957-60: Researcher in Nuclear Electronics at CISE, Milano,
1960-62: Research Associate on Lasers, Dept. EE, Stanford University,
1962-70: Leader Research Group on Lasers at CISE Milano,
1963-70: Associate Professor of Physics, Milan University,
-- Visiting scientist at:
- 1968-69: IBM Res. Lab. Ruschlikon (CH);
- 1978 and 1985: IBM Res. Lab. San Jose, (CA);

1969-70: Visiting Professor, Dept. of Phys., MIT;
1970-77: Chair of Physics, University of Pavia;
1977- present: Chair of Physics, University of Firenze;

1975 -2000 : President of Istituto Nazionale di Ottica (INO) , later transformed into Istituto Nazionale di Ottica Applicata (INOA);
2001: Scientific Associate of INOA

Main scientific contributions:

1) Cooperative effects in quantum optics
2) Photon statistics and laser fluctuations
3) Deterministic chaos in optics
4) Pattern formation in extended media
5) Complex phenomena and cognitive processes

Publications

- Scientific papers: more than 350.
- Communications to scientific meetings: more than 350.
- More than 10 Books, including:

Laser Handbook, vol. 1 and 2. (with E. Schulz Du Bois), North Holland 1972;
Instabilities and Chaos in Quantum Optics (with R.G. Harrison), Springer 1987;
I simboli e la realtà, Jaca Book, (with I. Arecchi), Milano 1990;
Optical chaos (selected papers on) (with R.G. Harrison), SPIE Opt. Eng. Press 1994;
Lexicon of Complexity (with A. Farini), Firenze 1996;
Caos e complessità nel vivente,IUSS,Pavia,2004;
also Co-Editor of many Proceedings of International Conferences or Schools

Prof. Francesco De Martini (Univ. of Roma "La Sapienza"): *"Quantum optical investigations of the foundations of modern physics and of quantum information"*

Abstract

A brief history of the developement of Quantum Optics in the last decades will be presented with a special emphasis on the theoretical concepts and on the instrumental methods introduced by that science as a contribution to the general endeavour aimed at the understanding of the most relevant, intriguing paradigm of modern Science: quantum mechanics. Concepts like quantum interferometry and quantum entanglement, quantum nonlocality, the macroscopic quantum superpositions and the "Schroedinger Cat" will be enlightened on the basis of the results of recent experiments. The perspective development of the field will also be discussed. At last the new science of Quantum Information will be presented together with its most recent technical applications.

Biography

Born in Novara, Italy. Laurea in Electrical Engeneering (Politecnico di Milano) in 1959.
D.S.R. Staff Member, Massachusetts Institute of Technology (1964-67) with Professor Charles H. Townes, Nobel Laureate.
Charge' de Recherches, Conseil National de La Recherche Scientifique, Universite' de Paris - Sud (1967-1970) with Professors J. Ducuing and A.Kastler, Nobel Laureate.
Libera Docenza in "Struttura della Materia" in 1979.
Full professor of Physics, since 1976 at the University of Naples (teaching the course on "Structure of Matter") and, since 1979 at the University of Rome "La Sapienza" (official courses: "Quantum Optics" and "Quantum Information").
Chairman of the Quantum Optics Laboratory at the Universita' di Roma "La Sapienza" since 1970. Author of 4 books and of 150 papers related to various modern aspects of nonlinear-optics of gases and solids, of solid-state nonlinear Spectroscopy of F-centers in alkali-halides and of surface and bulk polaritons, of free-electron lasers. Inventor of the relativistic coherent X-ray up-converters (1980). In the decade 1980-1990 his activity was mailny focused on the investigation of the quantum statistical properties of the electromagnetic radiation generated in the active microscopic optical.cavity ("micro-cavity"). This device, and the corresponding "lasing" counterpart ("microlaser"), were first proposed and demonstrated experimentally by Prof. De Martini and co-workers correspondingly in 1987 and in 1988.
Since 1990 Professor De Martini was active on the field of non-linear parametric generation and manipulation of two-particle quantum "entangled-states". These were and are presently adopted in the Quantum Optics Laboratory in Roma for fundamental tests of the basic nonlocality of quantum reality, including E.P.R. paradox and Bell inequalities and Quantum State Teleportation. In 1997, in the same Quantum Optics Laboratory the first successful experiment of Quantum State Teleportation was achieved. Another application of the parametrically generated entanglement, presently investigated by Prof. De Martini, consists of the first esperimental realization of an all-optical "Schroedinger-cat" system (i.e. composed of two semi-classical systems in quantum superposition) as an basic device to be adopted within a modern quantum computation scheme. More recent realizations in the domain of Quantum Information, including the processes of Quantum Cloning, Universal-Not gate, Entanglement Witness, detailed studies in Quantum Measurement Theory and fundamental tests of quantum mechanics are outlined below with the corresponding published works.
In 2004 Francesco De Martini was granted by the Prize of the Accademia Nazionale dei Lincei for Physics. In 2007 he was also called to join as a member the same Accademia dei Lincei.
The detailed scientific activity of Prof. De Martini including published books and papers is expressed by 250 scientific publications.

Prof. Orazio Svelto (Politecnico di Milano): "*Ultrafast science: from picosecond to attosecond laser pulses"*

Abstract

Since last few hundred years, short light pulses have been used by the mankind to either studying the dynamical behaviour of light-matter interaction or to send intelligent signals. In this context, the invention of the laser and the introduction of the corresponding dynamical behaviour referred to as *mode-locking* have dramatically reduced the time scale of achievable light pulses by about three orders of magnitude (i.e. from nanoseconds to picoseconds). The first 20 years of ultrafast laser science have thus been devoted to exploring the dynamical behaviour of solids and liquids with picosecond time resolution.

The introduction of widely-tunable dye and solid-state lasers and the appropriate control of laser-cavity dispersion has then allowed a further reduction of time duration by about two order of magnitudes i.e. down to the hundreds femtosecond regime (1 fs = 10^{-15} s). Complex phenomena such as intraband relaxation in liquids and semiconductors as well as the dynamic of fast chemical reactions have then been explored. The interest and quality of this research is also testified by the Nobel prize for Chemistry being awarded, in 1999, to Ahmed H. Zewail for "his studies of the transition states of chemical reactions using femtosecond spectroscopy"**.**

A further important advance has been possible through the idea of pulse compression. In this way a reduction of pulse duration down to a few femtoseconds has been achieved. The invention of the so-called hollow-fiber compressor has then allowed to compress laser pulses of relatively high energy (i.e. in the mJ range) down to a few (4-5) femtosecond. Such short laser pulses comprise only a few cycles of the carrier wave and are currently used in a few laboratories to studying the coherent vibrational behaviour of solids and polymers. Furthermore, when coupled with the high peak intensity achievable at the focal spot of a lens (> 10^{16} W/cm^2), these near-single-cycle laser pulses are widely used in many laboratories for studying the nonlinear-optical behaviour of laser-matter interaction under extreme conditions of pulse duration (the field is now referred to as *extreme nonlinear optics*). One of such phenomena has, in particular, been widely studied namely high-harmonic generation in noble gases. The phenomenon allows the generation of a wide harmonic spectrum of the fundamental exciting wavelength extending up to about the 100th harmonic. Since the exciting wavelength is around 800 nm, one can then obtain a high-harmonic spectrum extending down to about 10 nm (i.e. in the XUV range).

When the high-harmonic spectrum is obtained using near-single-cycle laser pulses and if certain conditions are fulfilled, single isolated harmonic pulses with duration of about 100 attoseconds have, quite recently, been obtained. One thus enter in a, as yet, almost completely unexplored field already referred to as *Attosecond Science*. In fact, such a short pulses are in principle able to studying the dynamic behaviour not, any more, of nuclei among themselves but of the electrons when moving around their parent ion. A new chapter has thus been opened in the field of ultrafast science and this chapter promises to give quite interesting results and to be long lasting.

Biography

- Born in Maglie (LE), Italy, on February 21, 1936

Academic career

- He received the degree in Nuclear Engineering from Polytechnic School of Milano in 1960
- From 1961 to 1962 he spent a research period, as a research associate, at Stanford University.
- From 1963 he was appointed as a researcher of the National Research Council (CNR)
- In 1966 he received the degree "Libera docenza" in Quantum Electronics.
- From 1970, he was appointed as Research Director of CNR.
- Since 1976 he is full professor of Quantum Electronics at the Polytechnic School of Milano.
- Since 1976, he was appointed as the Director of the Center of Quantum Electronics of CNR. This Center, since 2002, has been transformed as a Section of the Institute of Photonics and Nanotechnologies of the CNR.

Key Experiences

- Diffraction-limited solid-state lasers
- Diode pumped Yb:Er:glass lasers
- Study and development of ultrafast solid-state lasers, from picosecond to femtosecond
- Application of ultrashort pulses to nonlinear optics
- Application of ultrashort pulses to biomedicine
- Pulse compression by the hollow-fiber technique (which led to the generation of the shortest pulses, so far, of 3.8 fs)

The research activity has led to the publication of more than 250 papers in international scientific journals and to numerous invited papers at international conferences. Author of the book "Principles of Lasers" published by Springer in New York (fourth edition, second printing, in 2004). The book has been translated in russian, chinese, greek, arabic, and farsi languages and is used at many international universities. Co-author of the book "Problems in Laser Physics" (Kluwer/Plenum, New York 2001).

Principal professional activities:

- Member and one of the founders of the Quantum Electronics Division of the European Physical Society
- Chairman of the program committee of the IX International Quantum Electronics Conference IQEC-1976 (Amsterdam, 1976)
- Chairman of the European program committee for the Conference on Lasers and Electrooptics – CLEO 85 (Baltimora, 1985)
- Chairman of the European program committee for the Conference on Lasers and Electrooptics – CLEO 90 (Baltimora, 1990)
- Member of the steering committee for CLEO-Europe
- General co-chair for the first CLEO-Europe conference (Amsterdam, 1994)
- Director at large of the Optical Society of America and member of the International Council
- Program co-chair for IQEC-2002 (Moscow, 2002)
- Director of the Center of Quantum Electronics of the National Research Council for more than 25 years

Honors

- Elected member of the Italian Academy "Istituto Lombardo, Accademia di Scienze e Lettere" (since 1989)
- Prize E. Borgia of the Italian Accademia dei Lincei for the invention of super-gaussian mirrors (1991)
- Elected member of Italian Academy of Sciences (since 1991)
- Prize Philip Morris for Research and Technology for the invention of the Erbium-Ytterbium laser for optical communications (1992)
- Fellow of the Institute of Electrical and Electronics Engineers (1992)
- Quantum Electronics Prize of the European Physical Society with the motivation "for pioneering and outstanding continuing activity in the field of ultrashort laser pulses and solid-state lasers" (1998)
- "Sergio Panizza" Prize of the Italian Physical Society for the invention of the hollow-fiber compressor (1999)
- Fellow of the Optical Society of America (1999)
- Italgas Prize for Research and Technological Innovation for "New Lasers for Optical Communications" (2000)
- Elected member of the Italian "Accademia Nazionale dei Lincei" (since 2004)
- Charles H. Townes Award of the Optical Society of America (2006) with the motivation "for pioneering work on ultrashort laser pulses and solid state lasers, and for the invention of the hollow-fiber compressor, leading to advances in extreme nonlinear optics and attosecond science"