

FEMTO



- Newsletter 2

FEMTO (Interaction of superintense, femtosecond laser fields with atoms, solids and plasmas) is a program of the European Science Foundation in the Physical and Engineering Sciences. For more information see the web site: [ht://www.esf.org/FEMTO/](http://www.esf.org/FEMTO/)



It is the wish of the Steering Committee to publish this Newsletter at least four times in the year. Contributions are welcome from all the groups working in the field. Any news or material to be included in this newsletter should be sent to Dimitri Batani at the email address batani@mi.infn.it or fax + 39 02 2392208

PHYSICAL & ENGINEERING SCIENCES

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- *Pressures of 100 Mbar reached in gold.
- *Harmonics from sub-10 fs laser pulses.

SUMMARY

*The FEMTO programme in brief

FORTHCOMING EVENTS:

- *Workshop on "Applications of high order harmonics", Lund, Sweden.
- *Conference on "Atoms and Molecules in Super-Intense Laser Fields" Maratea, Italy.
- *Summer school on "Matter in Super-intense Laser Fields" in Erice.

NEWS:

- *Workshop on "Relativistic Effects in Laser-Matter Interactions"

FROM THE LABORATORIES:

FEMTO in brief

The Programme on "Interaction of superintense, femtosecond laser fields with atoms, solids and plasmas" (short name: FEMTO) is a programme of the European Science Foundation in the Physical and Engineering Sciences. Its chairman is Prof. Charles Joachain from the Université Libre in Brussels. FEMTO arises from the merging of two previous proposals "Interaction of superintense, femtosecond laser fields with atoms and solids" presented to the ESF by C.Joachain and "Fast Ignitor Physics with short pulse high intensity lasers" presented by D.Batani (Università di Milano - Bicocca). One goal of the programme is hence to bring together the scientific communities of atomic and plasma physics.

Research will focus on the following areas at the forefront of the rapidly expanding domain of femtosecond laser interactions:

1. Multiphoton ionisation of atoms in strong fields.
2. Dynamics of small molecules intense laser fields.
3. New physical mechanisms and novel applications for high-order harmonic generation.
4. Generation of pulses in the attosecond range.
5. Relativistic effects in laser-atom and laser-plasma interactions.
6. Physics related to the "fast ignitor" approach to inertial confinement fusion (ICF).
7. Study of exotic states of matter for basic physics and astrophysics.

The contributing organisations are:

Belgium:

Fonds National de la Recherche Scientifique

Germany:

Max-Planck-Gesellschaft (MPG); Hermann
v.Helmholtz-Gemeinschaft Deutscher Forschungs-
szentren (HGF)

Italy:

Istituto Nazionale per la Fisica della Materia (INFN);
Consiglio Nazionale delle Ricerche (CNR)

France:

Centre National de la Recherche Scientifique (CNRS);
Commissariat à l'Energie Atomique (CEA)

Portugal:

Instituto de Cooperaçao Ciêntifica e Tecnológica
Internacional

Sweden:

Naturvetenskapliga Forskningsradet

Czech Republic:

Academy of Sciences of the Czech Republic.

Most of the activities of the programme are co-ordinated by a "Core Committee" whose members are D. Batani, C.J. Joachain, M. Koenig and W. Sandner. ESF Contacts are Mrs. Catherine Werner or Dr. Hans U. Karow. Email: cwerner@esf.org Fax: +33 (0) 3 88 37 05 32

The programme includes the following activities:

1. EURESCO Conferences and SUMMER SCHOOLS
2. WORKSHOPS
3. GRANTS and SHORT VISITS.

For grants and short visits see the information the web site. These are funded respectively up to the amount of

5000 and 10000 French Francs. Applications are required at least two weeks in advance.

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announcement



LUND
UNIVERSITY

Workshop on "Applications of High-Order Harmonics" Lund, March 2000

In the frame of the scientific activity of the FEMTO programme, a workshop will be held in Lund (Sweden) on March 17-18, 2000 about the "Applications of High-Order Harmonics".

The main goal is to bring together scientists from different communities in order to discuss possible applications of high-order harmonics in different areas of science. The programme will consist of general, introductory talks as detailed below, and a poster session.

Workshop chair:
Anne L'Huillier

Co-chair:
Claes-Göran Wahlström

The workshop is financially supported by the European Science Foundation and the Lund Laser Centre.

Updated information on the workshop and the program can be found on the web page: http://www-llc.fysik.lth.se/esf_workshop.

The success of the workshop was proven by the presence of about 50 scientists from various countries.

Workshop organisers:



Alfred Maquet,
Laboratoire de Chimie Physique-Matière et Rayonnement
Université Pierre et Marie Curie,
(Unité Mixte de Recherches du CNRS, UMR 7614)
11, rue Pierre et Marie Curie, F-75231 Paris Cedex 05
France
Tel: +33 (0)1 44 27 62 77
Fax: +33 (0)1 44 27 62 26
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web site : [ht://www.ccr.jussieu.fr/lcpmr/](http://www.ccr.jussieu.fr/lcpmr/)

Pierre Agostini
DSM/DRECAM
Service des Photons Atomes et Molécules
Centre d'Etudes de Saclay 91191 Gif Sur Yvette
Tel +33 016 908 5162
Fax +33 016 908 8707
e-mail agop@santamaria.saclay.cea.fr

LIST OF SPEAKERS

C. Joachain N. Kylstra	The FEMTO programme Overview of relativistic effects in laser-matter interactions
J.C. Adam	Parametric instabilities, electron heating and ultra intense laser propagation in slightly underdense plasma
C. Keitel M.V. Fedorov W. Becker	Relativistic laser-ion interaction Relativistic ponderomotive forces Elementary decay processes and reactions on the background of a superintense laser field
H. Ruhl	Collective absorption and transport of large mass and energy currents in ultrarelativistic laser-matter interactions
P. Monot	Electron temperature studies of optical-field ionised N ₂ plasma at 10 ¹⁹ Wcm ⁻²
D. Batani E. Fill	Experiments on fast electron generation at LULI Hot electron generation and suprathermal electron transport in copper
D. Milosevic	Relativistic effects in potential scattering of electrons in ultrastrong laser field
G. Gahn	On the generation of multiMeV electrons using femtosecond pulses
R. Taieb	Relativistic effects in laser-atom interactions

J. Ullrich
R. Gayet

A. Pukhov
K. Rzazewski

F. Faisal
D. Zaretsky

L. Roso
M.W. Walser

C. Joachain

Multiple ionisation dynamics in extreme fields
A simple non-perturbative approach of atom ionisation
by intense ultrashort laser pulses
PIC simulations of laser-plasma interactions
Pump-probe test of the relativistic moving mirror
model
Single attosecond pulse from Free Electron Lasers
Multiphoton emission of radiation by a relativistic
electron beam in a magnetic undulator
Volkov wave packets
Influence of spin-laser interactions on relativistic
harmonic generation
Concluding remarks

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announcement

Erice Summer School on "ATOMS, SOLIDS AND PLASMAS IN SUPER- INTENSE LASER FIELDS"

The Ettore Majorana Centre in Erice (Sicily) will host a summer school on "Atoms, Solids and Plasmas in Superintense Laser Fields" on July 8-14, 2000.

PURPOSE OF THE COURSE

The advent of laser systems capable of delivering very short pulses and very high intensities has made accessible new regimes to experimental investigations and has opened new horizons in the interaction of laser fields with atoms, solids and plasmas. In these extreme conditions, electrons are accelerated at velocities close to the velocity of light and the electromagnetic fields are much bigger than the atomic electric fields, so that strongly non-linear and relativistic interactions take place. The traditional distinction between solids and atoms on one side and plasmas on the other side tends to vanish and exotic states of matter are created. A large variety of applications is expected, from novel light and X-ray sources from high harmonics emission, to new particle acceleration techniques and the new "fast ignition" approach to Inertial Confinement Fusion. The Course will cover areas of interest to the atomic physics and to the plasma physics scientific communities and is opened in particular to students and researchers wishing to enter this new field. Lectures and specialised seminars will cover current developments in theory and experiments but are also intended to give the basics of the field. The course falls

among the activities of the Programme "FEMTO" (Interaction of superintense, femtosecond laser fields with atoms, solids and plasmas), a program of the European Science Foundation in the Physical and Engineering Sciences.

GENERAL INFORMATION

Advanced research papers by participants of the Course are welcome for presentation (a poster session is planned) and will be considered for publication in the Proceedings of the Course together with the invited lectures.

Persons wishing to attend the Course, and those wishing to present a contribution, should apply to:

Prof. Giovanni Petrocelli
Dipartimento di Scienze e Tecnologie Fisiche ed Energetiche
Università di Roma "Tor Vergata"
Via di Tor Vergata n. 110
I-00133 ROME (Italy)
tel.: +39 06 7259 7211 or 7246
fax: +39 06 7259 7145
e-mail: petrocelli@uniroma2.it

They should specify:

- i) full name(s), address, age, nationality;
- ii) academic qualifications and degree;
- iii) present position and place of work;
- iv) current research activity;
- v) list of publications

Junior scientists should enclose a letter of recommendation from the head of their research group or from another senior scientist active in the field.



*The Centre is named after the famous Sicilian physicist
Ettore Majorana*

The total fee, which includes full board, a copy of the proceedings and lodging (arranged by the School), is US \$400. Thanks to the generosity of the sponsoring Institutions, a special support can be granted to some deserving students who need financial help. Request to this effect must be specified and justified in the letter of application which, in this case, must be received before May 1st.

Closing date for application: June 26, 2000

No special application form is required

Admission to the Course will be decided in consultation with the Advisory Committee of the School comprising Professors C.J.Joachain, D.Batani, A.N.Chester, S.Martellucci, and A. Zichichi. Participants must arrive in Erice on July 8, no later than 5 pm and leave no earlier than July 14 at 1 pm.

The scientific committee of the school is composed by Professors C.J.Joachain, D.Batani, A.N.Chester, S.Martellucci, P.Knigh, A.Maquet, W.Sandner and H.Walther. Detailed information and the final programme of the Course, including timetable of lectures, will be sent to successful applicants together with the letter of acceptance.

Directors of the Course:

C.J. Joachain, D. Batani

Directors of the School:

A.N. Chester, S. Martellucci

Director of the Centre:

A. Zichichi

The course is sponsored by the Italian Ministry of Education, the Italian Ministry of University and Scientific Research, the Sicilian Regional Parliament, the Italian Research Group on Quantum Electronics and Plasma Physics (G. N. E. Q. P.), of the National Research Council, the University of Rome "Tor Vergata", the University of Milano-Bicocca, the Istituto Nazionale Fisica della Materia (I.N.F.M.) and the European Science Foundation.

PROGRAMME AND LECTURERS

<ul style="list-style-type: none"> • P. Agostini, CEA, Saclay, France • F. Amiranoff, LULI, Ecole Polytechnique, Palaiseau, France • S. Atzeni, Università di Roma, Italy • P. Burke, Queen's University, Belfast, UK • M. Dörr, Max Born Institut, Berlin, Germany • K. Eidmann, Max Planck Institut für Quantenoptik, Garching, Germany • F.Faisal, University of Bielefeld, Germany • J. C.Gauthier, LULI, Ecole Polytechnique, Palaiseau, France • M.Gavrila, FOM, Amsterdam, The Netherlands • C.Keitel, University of Freiburg, Germany • M. Key, Lawrence National Laboratory Livermore, USA • M. Koenig, LULI, Ecole Polytechnique, Palaiseau, France • N. J. Kylstra, University of Durham, UK • J. Meyer-ter-Vehn, Max Planck Institut für Quantenoptik, Garching, Germany • G. Mourou, University of Michigan, USA • G.Paulus, Max Planck Institut für Quantenoptik, Garching, Germany • F. Pegoraro, Università di Pisa, Italy • A. Pukhov, Max Planck Institut für Quantenoptik, Garching, Germany • H. Rottke, Max Born Institut, Berlin, Germany • P. Salieres, CEA, Saclay, France • J.Tisch, Imperial College, London, UK • V.Veniard, Université Pierre et Marie Curie, Paris, France 	<p>Experiments of multiphoton ionisation of atoms Laser acceleration of electrons</p> <p>Introduction to laser produced plasmas Theory of multiphoton dissociation and ionisation of molecules R-matrix-Floquet theory of two-electrons atoms in intense laser fields Plasmas at solid state density</p> <p>Double ionisation in intense laser fields Dense plasmas</p> <p>Stabilisation of atoms in super-intense laser fields Relativistic dynamics in super-intense laser fields Experiments on intense laser produced plasmas</p> <p>Shock wave experiments and equation of state of dense matter Theory of multiphoton ionisation of atoms Relativistic plasmas</p> <p>Basics of short, super-intense laser pulses Classical and quantum strong-field ionisation</p> <p>Magnetic fields and solitons in relativistic plasmas PIC simulations of laser-plasma interactions</p> <p>Experiments of multiphoton dissociation and ionisation of molecules High Order Harmonic Generation Interaction of clusters with laser fields Relativistic effects in laser-atom interactions</p>
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The Torre del Balio and Norman Castle

POETIC TOUCH

According to legend, Erice, son of Venus and Neptune, founded a small town on top of a mountain (750 metres above sea level) more than three thousand years ago. The founder of modern history - i.e. the

recording of events in a methodic and chronological sequence as they really happened without reference to mythical causes - the great Thucydides (~500 B.C.), writing about events connected with the conquest of Troy (1183 B.C.), says: "*After the fall of Troy some Trojans on their escape from the Achaei arrived in Sicily on boats and as they settled near the border with the Sicilians all together they were named Elymi: their towns were Segesta and Erice*". This inspired Virgil to describe the arrival of the Trojan royal family in Erice and the burial of Anchise, by his son Enea, on the coast below Erice. Homer (~ 1000 B.C.). Theocritus (~300 B.C.), Polybius (~200 B.C.), Virgil (~50 B.C.), Horace (~20 B.C.) and others have celebrated this magnificent spot in Sicily in their poems. During seven centuries (XIII-XIX) the town of Erice was under the leadership of a local oligarchy, whose wisdom assured a long period of cultural development and economic prosperity which in turn gave rise to the many churches, monasteries and private palaces which you see today.

In Erice you can admire the Castle of Venus, the Cyclopean Walls (~800 B.C.) and the Gothic Cathedral (~1300 A.D.). Erice is at present a mixture of ancient and medieval architecture. Other masterpieces of ancient civilisation are to be found in the neighbourhood: at Motya (Phoenician), Segesta (Elymian), and Selinunte (Greek). On the Aegadian Islands - theatre of the decisive naval battle of the first Punic War (264-241 B.C.) - suggestive neolithic and paleolithic vestiges are still visible: the grottoes of Favignana, the carvings and murals of Levanzo.

Splendid beaches are to be found at San Vito Lo Capo, Scopello, and Cornino, and a wild and rocky coast around Monte Cofano: all at less than one hour's drive from Erice.

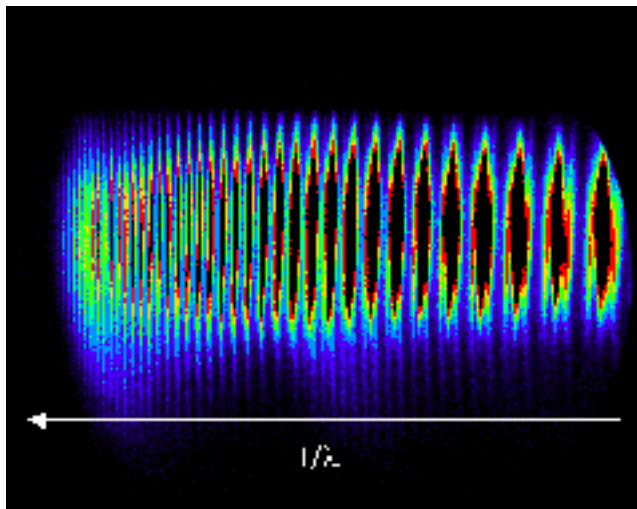
More information about the activities of the Ettore Majorana Centre can be found on the WWW at the following address:

<http://www.ccsem.infn.it>

High order harmonics generated by sub-10 fs laser pulses

Coherent extreme ultraviolet (xuv) light is essential in a number of applications in physics, chemistry and biochemistry. High order harmonics of laser pulses provides a unique source of high brightness, coherent radiation in this spectral region.

The recent progress in the laser technology has led to the generation of extremely short light pulses: self-phase modulation



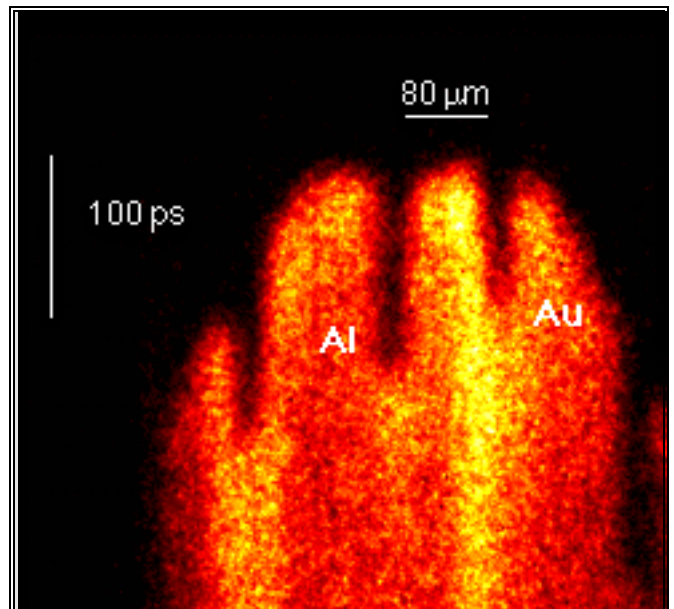
in hollow fibers filled with noble gasses, followed by compression in a dispersive delay line, allows to achieve few optical cycle pulses with energies of hundreds of microjoules. This technique has been demonstrated at the Department of Physics of Politecnico of Milan (Italy). By focusing such pulses in noble gasses, the high order harmonics generation process becomes very efficient and can occur in a time less than an optical cycle of the fundamental radiation. This opens up the way to the production of attosecond pulses in the xuv spectral region. The high order harmonic spectrum reported in the figure is generated by focusing 200 microjoule, 7 fs duration pulses at 800 nm in a helium gas jet. The peak intensity in the focal region is of the order of 10^{15} W/cm². The xuv emission is analysed through a spectrograph by means of a two dimensional detector. The image of the harmonic spectrum extends up to 7 nm (horizontal direction) and presents a well-resolved structure. Experiments are underway to fully characterise the harmonic emission in terms of divergence (vertical direction, in the figure) and photon yields. The xuv source and the detection system, located at the Politecnico of Milan, were built in collaboration with teams from Universities of Padova and Naples, with a financial support from the national Institute of Physics of Matter (I.N.F.M.).

Record pressure of 100 Mbar reached in gold

The highest pressure (100 Mbar) ever reached in an equation of state (EOS) experiment has been achieved in gold with the ASTERIX laser source in Max Planck Institut für Quantenoptik. The laser beam delivers up to 400 J pulses in 0.45 ns at a wavelength of 435 nm (3ω), with an intensity on target of about 10^{14} W/cm² and producing strong shocks in solid targets. The figure shows the image of the temporal evolution of the rear face of the target recorder with a streak camera

as the shock emerges and heats the material, inducing light emission; the two steps of Al and Au are indicated. The EOS point for Au has been found taking the known EOS of Al as a reference and using the impedance matching technique. The experiment has shown a deviation from existing EOS model for gold (e.g. the Sesame tables).

The experiment has been supported by the E.U. Programme "Access to Large Scale Facilities", and has been jointly conducted by the teams of LULI (M. Koenig), the University of Essex (T. Hall), the University of Milano-Bicocca (D. Batani) and Max Planck (Th. Löwer). The paper will appear (probably in April) in Physical Review B.



CONFERENCE ON:
ATOMS AND MOLECULES IN SUPER-INTENSE LASER FIELDS

MARATEA, ITALY, SEPTEMBER 9-14, 2000.

- Chairman: C. J. Joachain (Univ. Brussels)
- Vice-chairman: D. Batani (Univ. Milano-Bicocca and INFN)
- Scientific Organising Committee: P. Agostini (Saclay), D. Batani (Univ. Milano-Bicocca and INFN), M. Gavrila (FOM Inst., Amsterdam and Inst. for Theoretical At. and Mol. Physics, Cambridge, Mass.), C.J. Joachain (Univ. Brussels), P. Knight (Imperial College, London), M. Koenig (Lab. LULI, Palaiseau), W. Sandner (Max Born Institut, Berlin), H. Walther (Max Planck Inst. for Quantum Optics, Garching)



The "Grotte di Fiumicello" are among the several natural attractions of the coast of Marates

SCOPE OF THE CONFERENCE

In recent years, very intense laser light has become available in the form of short pulses of femtosecond duration. At these intensities, atoms and molecules are exposed to extreme conditions and new phenomena occur, such as the multiphoton ionisation of atomic and molecular systems, the emission by atoms of very high order harmonics and the Coulomb explosion of molecules. These phenomena generate new behaviour of bulk matter in intense laser fields, with great potential for wide ranging applications. This conference will focus on the experimental and theoretical study of atoms and molecules with super-intense laser fields. The interaction of solids and plasmas with femtosecond laser pulses will also be discussed.

PUBLICITY:

Information about the conference can be found in the EURESCO web-site: <http://www.esf.org/euresco>

It is also possible to fill in an on-line application form. A paper version of the Preliminary Programme with an application form can be obtained upon request from the Euresco Office - please quote the conference title:

European Research Conferences (Euresco)

European Science Foundation

1 quai Lezay Marnesia, F - 67080 Strasbourg, France

Tel +33 388 76 71 35, Fax +33 388 36 69 87

Email euresco@esf.org

A good number of grants will be available for young researchers who are citizens of the European Union and Associated States, aged 35 or under (preferably closer to 35 with fairly good research experience). Grants will cover the conference fee and possibly also some travel costs. Some grants may also be available for candidates from Central and Eastern European countries. See the EURESCO web site for further details.

A poster session is planned for contributions by young participants.

EURESCO PROGRAMME:

The EURESCO Programme, which was started in 1990, is run by the European Science Foundation with co-sponsoring from the Euroconferences Activity of the European Union and, more recently, with additional funding from the European Science Foundation. The Conferences are mainly held throughout the European Union and Associated States. Besides natural and life sciences, the EURESCO Programme covers technical sciences, economics, social sciences and humanities - as well as interdisciplinary areas. Each conference consists of a series of meetings, held typically every other year. There are neither written contributions nor proceedings. Unconventional ideas and new approaches, not yet fully explored, are encouraged. New ideas and results discussed during the meeting should not be cited in publications without the explicit permission of their author. The conferences are open to all scientists, whether from academia or industry. The number of participants is limited to about 100 and all participants are expected to attend for the whole duration of the Conference. Selection is made on the basis of the affinity of potential participants with the topics of the conference. A Conference Fee covering board and lodging and a registration fee, including social programme (if any) and group transportation (if any) is charged to participants and a fee covering board, lodging and social programme is charged for accompanying guests.

SCIENTIFIC PROGRAMME

<p>* Session 1. Multiphoton ionisation of atoms</p> <ul style="list-style-type: none"> - G. Paulus (MPQ, Garching) - K. Taylor (Queen's Univ. Belfast) - B. Piraux (Univ. Louvain-la-Neuve) - F. Faisal (Univ. Bielefeld) - R. Potvliege (Univ. Durham) - P. Lambropoulos (MPQ, Garching) <p>* Session 2. Multiphoton ionisation and dissociation of molecules</p> <ul style="list-style-type: none"> - H. Rottke (Max Born Inst. Berlin) - P.G. Burke (Queen's Univ. Belfast) - P. Van Leuven (VUB, Brussels) - J. McCann (Queen's Univ. Belfast) - H. Figger (MPQ, Garching) - Annick Suzor-Weiner (Univ. P. et M. Curie, Paris) <p>* Session 3. Harmonic generation</p> <ul style="list-style-type: none"> - P. Salières (Saclay) 	<p>"Quantum effects in strong-field ionisation"</p> <p>"Time-dependent multiphoton processes in helium"</p> <p>"Two electron atoms in intense short laser pulses"</p> <p>"Double ionisation in intense laser fields"</p> <p>"Floquet dynamics in ultra-short pulses"</p> <p>"Coherent control of atomic ionisation"</p> <p>"Dynamics of small molecules in intense laser fields"</p> <p>"R-matrix-Floquet theory of multiphoton processes in molecules"</p> <p>"On the mechanism of infrared multiphoton absorption by diatomics in intense laser fields"</p> <p>"Dissociative ionisation of molecules at high intensity"</p> <p>"Molecular bond softening in intense laser fields"</p> <p>"Coherent control of molecular dissociation"</p> <p>"High order harmonics generation"</p>
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- M. Lewenstein (Univ. Hannover)	"Theory of harmonic generation"
- C-G. Wahlström (Lund Inst. of Technology)	"Manipulation of high-order harmonics in space and time"
- T. Brabec (Technical Univ. of Vienna)	"High-order harmonic generation using femtosecond laser pulses"
- L. Roso (Univ. of Salamanca)	"Generation of single attosecond pulses from free electron lasers"
- J. Tisch (Imperial College, London)	"High harmonic generation from clusters"
* Session 4. Relativistic effects in laser-atom interactions	
- A. Maquet (Univ. P. et M. Curie, Paris)	"Laser-atom interactions in the relativistic regime"
- N. Kylstra (Univ. Durham)	"Relativistic effects in laser-atom interactions at ultra-high intensities"
- A.M. Ermolaev (Univ. Brussels)	"Relativistic high-frequency theory and applications"
- R. Taieb (Univ. P. et M. Curie, Paris)	"Relativistic calculations in laser-atom interactions"
- C. Keitel (Univ. Freiburg)	"Relativistic laser-atom dynamics"
* Session 5. Laser interactions with solids and plasmas	
- P. Mulser (Univ. of Darmstadt)	"Ultra-strong laser-solid and laser-plasma interactions"
- E. Fill (MPQ, Garching)	"Hot electrons generation and transport in solid materials"
- F. Bijkerk (FOM Institut Rijnhuizen)	"X-ray sources from femtosecond laser pulses"
- M. Borghesi (Imperial College, London)	"Experiments on plasma channelling in preformed plasmas"
- J. Davies (GOLP, Portugal)	"Fast electron generation experiments revisited in view of the effects of self generated high electric fields"
- P. Audebert (LULI, Ecole Polytechnique, Palaiseau)	"X-ray and fast electron preheat in small scale femtosecond laser experiments"
* Session 6. Generation of ultra-intense laser pulses and future directions	
- S. de Silvestri (Politecnico di Milano)	"Generation of short pulses by the hollow fiber technique and its application to high harmonics of few optical cycles"
- G. Mourou (Univ. of Michigan)	"Future directions in ultra-high intensity laser physics"

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1 quai Lezay Marnesia	