Symposium Relativistische Laserplasmen (SYRL)

gemeinsam veranstaltet von
Fachverband Plasmaphysik
Fachverband Kurzzeitphysik

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Übersicht der Hauptvorträge und Fachsitzungen

(Hörsaal 6C)

Hauptvorträge

SYRL 1.1	Fr	10:30–11:00	6C	**Relativistic mirrors with two colliding laser pulses** — •Sergei Bulanov
SYRL 1.2	Fr	11:00–11:30	6C	**Lösung eines 20 Jahre alten Problems: Zur Physik der stoßfreien Absorption ultrakurzer Laserpulse** — •Peter Mulser, Dieter Bauer, Hartmut Ruhl
SYRL 1.3	Fr	11:30–12:00	6C	**The new world of relativistic laser plasmas and applications** — •Juergen Meyer-ter-Vehn
SYRL 1.4	Fr	12:00–12:30	6C	**Relativistic laser-plasmas: novel sources of x-rays and particle beams** — •Alexander Pukhov
SYRL 2.1	Fr	14:00–14:30	6C	**Ultrafast proton acceleration in relativistic laser plasma** — •Peter Nickles, Matthias Schnürer, Thomas Sokollik, Sargis Ter Avetisyan, Wolfgang Sandner, Munib Amin, Toma Toncian, Oswald Willi
SYRL 2.2	Fr	14:30–15:00	6C	**Ionenbeschleunigung mit intensiven Laserpulsen** — •Heinrich Schwoerer, Sebastian Pfotenhauer, Oliver Jäckel, Jens Polz
SYRL 2.3	Fr	15:00–15:30	6C	**High-Intensity Laser Ion Acceleration** — •Jörg Schreiber, Friedhelm Bell, Florian Grüner, Michael Geissler, Stefan Karsch, Andreas Henig, Ulrich Schramm, Manuel Hegelich, Ferenc Krausz, Dietrich Habs
SYRL 2.4	Fr	15:30–16:00	6C	**Proprieties of Laser Triggered Micro Lens for Energy Selection and Focusing of MeV protons** — •Toma Toncian

Fachsitzungen

SYRL 1.1–1.4	Fr	10:30–12:30	6C	**Relativistische Laserplasmen**
SYRL 2.1–2.4	Fr	14:00–16:00	6C	**Relativistische Laserplasmen**

SYRL 1: Relativistische Laserplasmen

Zeit: Freitag 10:30–12:30 Raum: 6C

Hauptvortrag SYRL 1.1 Fr 10:30 6C

Relativistic mirrors with two colliding laser pulses — •Sergei Bulanov — Advanced Photon Research Centre, Japan Atomic Energy Agency, 8-1 Umemidai, Kizu, Souraku, Kyoto, 619-0215 Japan

In a plasma wake wave generated by a relativistically intense ultrashort laser pulse, modulations of the electron density naturally and robustly take the shape of paraboloidal dense shells, separated by evacuated regions, moving almost at the speed of light. When another counter-propagating laser pulse is injected, it is partially reflected from the shells, which act as relativistic flying semi-transparent mirrors. This process produces an extremely time-compressed frequency-multiplied electromagnetic pulse which may be focused tightly to the diffraction limit [1]. Recently the frequency multiplication was detected in the APRC-JAEA experiments on the reflection of a weak laser pulse in the region of the wake wave generated by the driver laser pulse in an underdense plasma [2]. This mechanism represents a new kind of short-pulse, tunable frequency source leading to the possibility of very strong pulse compression and extreme light intensification.

[1] S. V. Bulanov, T. Zh. Esirkepov, T. Tajima, Phys. Rev. Lett. 91, (2003).

[2] M. Kando, et al., (2007)

Hauptvortrag SYRL 1.2 Fr 11:00 6C

Lösung eines 20 Jahre alten Problems: Zur Physik der stoßfreien Absorption ultrakurzer Laserpulse — •Peter Mulser[1], Dieter Bauer[2] und Hartmut Ruhl[3] — [1]Theoretische Quantenelektronik (TQE), TU Darmstadt, Hochschulstr. 3, 64289 Darmstadt — [2]Max-Planck-Institut für Kernphysik, Postfach 103980, 69029 Heidelberg — [3]Institut für Theoretische Physik I, Ruhr-Universität Bochum, 44797 Bochum

Particle-in-Cell (PIC)-, Vlasov- und molekulardynamische Simulationen zeigen, dass intensive fs-Laserpulse in idealen stoßfreien Plasmen sehr gut absorbiert werden (über 50% Absorption). Seit zwanzig Jahren werden immer wieder neue Absorptionsmodelle vorgestellt, die aber nicht überzeugend sind. Eine Ausnahme mit Einschränkungen bildet das Modell von Brunel. Durch die Formulierung eines NO-GO-Theorems kann gezeigt werden, dass ein ideales stoßfreies Plasma in beliebiger nichtlinearer, aber regulärer Dynamik nicht absorbieren kann, wohl aber, wenn die Bewegung singulär wird. Dies legt den Schluss nahe, dass es Plasmaresonanzen sind, die die Adiabasie brechen. Eine eingehende Untersuchung zeigt in der Tat, dass anharmonische Resonanz vorliegt und dass diese die hohe stoßfreie Absorption in den Simulationen auf zwangslose Art erklären kann. Überdies gibt das Resonanzmodell Hinweise auf Beeinflussung und Steuerung von Absorption und Spektren der heißen Elektronen.

Hauptvortrag SYRL 1.3 Fr 11:30 6C

The new world of relativistic laser plasmas and applications — •Juergen Meyer-ter-Vehn — Max-Planck-Institute for Quantum Optics, Garching, Germany

Ultra-short high-power laser pulses with intensities beyond 10^{18} W/cm^2 now drive target electrons to the velocity of light and create dense relativistic plasmas in table-top experiments. The relativistic interaction with gas and solid targets leads to a number of surprising new phenomena, which were first predicted by numerical simulation and have now been impressively confirmed in experiments. Well collimated, ultra-bright electron (up to GeV energy) and ion beams have been observed. They are accelerated over hundreds of micrometer rather than hundreds of meter as in conventional accelerators. High laser harmonics up to keV energies involving ultra-bright attosecond pulses have been created at plasma surfaces acting as relativistic mirrors. Physics and applications are discussed in this talk.

Hauptvortrag SYRL 1.4 Fr 12:00 6C

Relativistic laser-plasmas: novel sources of x-rays and particle beams — •Alexander Pukhov — Institute for Theoretical Physics I, Uni-Duesseldorf

Laser plasma becomes relativistic at intensities I well above 10ˆ18 W/cmˆ2. One of the main applications for relativistic laser plasmas is the high-gradient particle acceleration and new table-top sources of short wavelength radiation. The main breakthrough happened in the last two years as a number of experimental groups reported monoenergetic electron beams from laser plasmas reaching GeV energies. These beams have been accelerated in the Bubble regime [Pukhov, Meyer-ter-Vehn, Applied Phys. B74, p.355 (2002)]. The main numerical tool to study the relativistic laser plasmas are particle-in-cell simulations. In the ultra-relativistic regime, I>>10ˆ18 W/cm2, the S-similarity theory [Pukhov, Gordienko, Phil. Trans. R. Soc. A364, p. 623 (2006)] helps to scale experimental results.

SYRL 2: Relativistische Laserplasmen

Zeit: Freitag 14:00–16:00 Raum: 6C

Hauptvortrag SYRL 2.1 Fr 14:00 6C

Ultrafast proton acceleration in relativistic laser plasma — •Peter Nickles[1], Matthias Schnürer[1], Thomas Sokollik[1], Sargis Ter Avetisyan[1], Wolfgang Sandner[1], Munib Amin[2], Toma Toncian[2], and Oswald Willi[2] — [1]Max-Born-Institut, Berlin, Germany — [2]Heinrich- Heine- Universität, Düsseldorf, Germany

We report on detailed investigations of ultrashort (˜ 40 fs,above 10E19 W/cm2) laser pulse driven ion acceleration from solid targets using sensitive single-shot particle diagnostic. Time- and spatially resolved ion/proton energy spectra and distributions, efficiencies in dependence on the laser pulse parameters such as pulse duration, intensity, and contrast ratio were studied and acceleration scenarios are discussed. The recorded distributions show that preferentially lower energetic protons/ions (<1MeV) have a wiggled structure, whereas protons with higher energy have an undisturbed ”continuous” distribution, witnessing of a fixed source size. Among the generation and characterization of laser driven ions/protons, the search for quasi-monoenergetic ions plays an outstanding role. Results to this topic showing bunches of ”mono-energetic” deuterons about 2 MeV are given.

Furthermore we report on first ”streaked” deflectometry of the development of fields at the rear side of a secondary plasma. Comparing this measurements of the temporal and 1D-spatial development and complimentary two-dimensional spatial snapshots with ray tracing calculations we inferred the scenario of an expanding field at the target rear side due to charge-up, charge compensation and ion front propagation processes.

Hauptvortrag SYRL 2.2 Fr 14:30 6C

Ionenbeschleunigung mit intensiven Laserpulsen — •Heinrich Schwoerer, Sebastian Pfotenhauer, Oliver Jäckel und Jens Polz — Institut für Optik und Quantenelektronik, Friedrich-Schiller-Universität, Max-Wien-Platz 1, 07743 Jena

Mit ultrakurzen und intensiven Lichtfeldern können Ionen auf kinetische Energien von vielen MeV beschleunigt werden. Die erzeugten Ionenstrahlen unterscheiden sich in Dauer, Intensität und geometrischen Strahlparametern deutlich von konventionell beschleunigten Ionenstrahlen. Der intensive Laserpuls wird dazu auf eine dünne Folie fokussiert, erzeugt darauf ein Plasma und beschleunigt zunächst Elektronen auf relativistische Energien. Diese Elektronen durchdringen die Folie und bauen ein im Vergleich zur Lichtperiode statisches Feld zwischen ihnen und der Folie auf, in dem Atome ionisiert und beschleunigt werden können. Wir berichten über Stand und Verständnis dieser neuen Beschleunigungsmethode und diskutieren insbesondere die Möglichkeiten zur Einflußnahme auf die Energieverteilung der Ionen.

Hauptvortrag SYRL 2.3 Fr 15:00 6C

High-Intensity Laser Ion Acceleration — •Jörg Schreiber[1,2], Friedhelm Bell[1], Florian Grüner[1], Michael Geissler[2], Ste-

fan Karsch[2], Andreas Henig[1,2], Ulrich Schramm[3], Manuel Hegelich[4], Ferenc Krausz[1,2], and Dietrich Habs[1] — [1]Department für Physik, Ludwig-Maximilians-Universität München, Germany — [2]Max-Planck-Institut für Quantenoptik, Garching, Germany — [3]Forschungszentrum Rossendorf, Dresden, Germany — [4]Los Alamos National Laboratory, Los Alamos, NM, USA

Electron and ion acceleration with highly intense laser pulses is a rapidly developing field of relativistic laser-plasma physics. During the last years the ultrashort (femtoseconds) high-density electron bunches could be produced with a nearly mono-energetic spectrum and GeV energies became accessible with table-top class lasers. While such electron bunches are produced in gases, at laser irradiated foils the relativistic electrons produce charge separation fields well above 10^{12} V/m which in turn accelerate a large number of ions ($10^{10} - 10^{13}$) with a small transversal emittance ($< 0.004\text{mm} \cdot \text{mrad}$) within less than one picosecond. The usually broad energy distribution of the ions could be narrowed by special target designs in two recent experiments. The production of relativistic solid density ion bunches will become possible in the near future. The application of laser accelerated ion beams could reach from compact fast-ion injectors for conventional particle accelerators over fast ignition for inertial confinement fusion to oncology and radiotherapy with ion beams.

Hauptvortrag SYRL 2.4 Fr 15:30 6C

Proprieties of Laser Triggered Micro Lens for Energy Selection and Focusing of MeV protons — •Toma Toncian — Institut für Laser- und Plasmaphysik, Heinrich-Heine-Universität Düsseldorf, 40225 Düsseldorf, Germany

The acceleration of MeV ions from the interaction of high- intensity laser-pulses with solids has major applicative prospects because of the high beam quality of this beams. However this beams are polyenergetic and divergent at the source. With the aid of a laser triggered micro lens tunable energy selection and focusing of MeV proton beams has been recently demonstrated (Toncian et. al. Science 312, 410 (2006)). A high intestity laser pulse is focused onto the wall of a hollow cylinder. The radial electric field associated to plasma expansion from the walls acts as a focussing lens on positive charged ions injected allong the axis of the cylinder. Here we present a more detailed studies of the proprieties of the laser triggered lens. Specially the dependence on triggering time and triggering pulse intensity of the focal length is addressed. The electron transport in the lens is discussed.