SYKL 2: Photo-nuclear reactions and MeV particle acceleration

Zeit: Dienstag 11:00–13:00 Raum: 1A

Hauptvortrag SYKL 2.1 Di 11:00 1A

Acceleration of particles by short ultra-intense laser pulses — •Oswald Willi — Institut für Laser- und Plasmaphysik, Heinrich-Heine-Universität Düsseldorf, 40225 Düsseldorf, Germany

The recent demonstration of the acceleration of energetic electrons, protons and ions by irradiation of matter by intense laser pulses has opened new perspectives for major applications in scientific, technological and medical areas. Quasi mono-energetic electrons with an energy up to one GeV and quasi mono-energetic protons in the several MeV range have been observed in recent experiments. These beams have interesting properties including small source size, high degree of collimation, short duration and large number densities allowing many potential novel applications. One of the applications is the diagnosis of high-density plasmas using protons allowing the transient electric and magnetic field generation mechanisms in laser-produced plasmas to be studied. For example, the electric fields responsible for the acceleration and expansion of multi-MeV protons from the rear surface of thin solid foils irradiated by an intense laser pulse or the electric fields inside a laser irradiated hollow metal cylinder which acts as an electrostatic micro-lens for proton focusing and energy selection can be measured. In addition, magnetic fields produced inside high density plasmas can be studied. In the presentation a summary of the latest experimental studies investigating electric and magnetic fields in laser produced plasmas will be discussed.

Hauptvortrag SYKL 2.2 Di 11:30 1A

Prospects for the application of laser-accelerated particle beams — •Ulrich Schramm — Forschungszentrum Dresden-Rossendorf (FZD), Germany

The field of laser-electron and laser-proton acceleration has matured over the last years to an extent that applications of laser-accelerated particle pulses can be envisaged in life science and material research. At the newly established 150TW laser lab of the FZ Dresden-Rossendorf we therefore prepare to exploit these technologies in close collaboration with the electron accelerator lab ELBE and the radiation biology departments of the center and of oncoray Dresden. Here, the status of the lab and first results will be reported.

Hauptvortrag SYKL 2.3 Di 12:00 1A

A Vision for Laser Induced Particle Acceleration and Applications — •Kenneth Ledingham — Department of Physics, University of Strathclyde, Glasgow G40NG, Scotland

Large particle accelerators like CERN and GSI have for more than half a century been at the vanguard of nuclear and particle physics revealing the fundamental building blocks and forces of nature. However the size and cost of these are fuelling serious efforts to develop new and more compact accelerator technologies. Recently it has been shown that ultra-intense lasers, via plasma conditions, can generate high intensity beams of electrons, photons, protons, neutrons and heavy ions. This talk will describe some of the experiments which have been carried out as proof of principle of this new field. The experiments which will be described were mostly carried out on large single pulse lasers which equally are large accelerators. One of the important applications of compact high power lasers is to PET isotope production and in the longer term to proton oncology.

New high intensity lasers sources with intensities $> 10^{23}$ Wcm^{-2} will be discussed and possible experiments they can perform.

However the future of this exciting field could be further developed by intense counter propogating laser beams which in principle could produce beams of positrons, muons and pions and even create particles from the vacuum. This of course could lead to γ-γ colliders. The possibility of creating Unruh radiation will also be discussed.

Hauptvortrag SYKL 2.4 Di 12:30 1A

Laser-Driven Recollisions: From Atomic to Nuclear Physics and Beyond — •Carsten Müller, Atif Shahbaz, Guido R. Mocken, Karen Z. Hatsagortsyan, and Christoph H. Keitel — Max-Planck-Institut für Kernphysik, Heidelberg

The interaction of atoms and molecules with intense laser fields can lead to electron recollisions with the parent ionic core due to the oscillating nature of laser fields. These collisions give rise to various nonlinear phenomena such as above-threshold ionization and high-harmonic generation. In the talk we report on recent theoretical studies on potential applications of the recollision mechanism in nuclear and high-energy physics [1,2]. To this end, the interaction of laser pulses with atoms, highly-charged ions, and exotic systems like positronium and muonic atoms is considered. It is shown that under suitable conditions, nuclear excitation can occur by the electronic charge cloud that is driven across the nucleus by the laser field. Moreover, the high-harmonic response from compact systems like muonic atoms exhibits signatures of the binding nucleus which might be useful for determination of unknown nuclear properties [1]. Finally, the recollision scheme can be extended to the highly relativistic regime by application of positronium atoms. This way, even particle reactions like muon production can be triggered in laser-driven electron-positron collisions [2].

[1] A. Shahbaz, C. Müller, A. Staudt, T. J. Bürvenich, and C. H. Keitel, Phys. Rev. Lett. 98, 263901 (2007)

[2] C. Müller, K. Z. Hatsagortsyan, and C. H. Keitel, Phys. Lett. B, accepted (arXiv:0705.0917)