P 20: Laser Plasmas I

Zeit: Mittwoch 14:00–15:45 Raum: HZO 30

Hauptvortrag P 20.1 Mi 14:00 HZO 30

Non-equilibrium Warm Dense Matter — •Andrew Ng — Department of Physics & Astronomy, University of British Columbia, Vancouver, Canada

Warm Dense Matter (WDM) refers to states in which the electron temperature is comparable to the Fermi energy and the ion potential energy exceeds their kinetic energy. Such states are governed by the complex interplay between electron degeneracy, excited electronic states and strong ion-ion coupling. Since its introduction in 1999 and the first International Workshop on Warm Dense Matter in 2000, WDM has emerged as a new frontier in plasma and condensed matter physics, attracting interest in broad disciplines including matter under extreme conditions, laser ablation, inertial confinement fusion, and planetary physics. While theoretical studies of WDM are challenging, experiments are equally daunting. With high energy densities, WDM cannot be readily confined in the laboratory. In unconfined states, gradients of temperature and density would develop rapidly and measurements can only be interpreted via complex numerical simulations. Advance in WDM science hinges on our ability to measure physical properties of uniform states. Currently, there are two primary approaches, namely, shock compression and isochoric heating of solids. In this talk, I will review the study of femtosecond-laser heated gold that is driving our understanding of non-equilibrium Warm Dense Matter physics related to lattice stability, high-energy-density solid phase, electron-ion coupling and electron kinetics.

P 20.2 Mi 14:30 HZO 30

Electric field development and ion dynamics at the magnetic cavity edge of laser produced plasma expansion — •Bo Ram Lee[1], Anton Bondarenko[2], Eric Clark[2], Carmen Constantin[2], Erik Everson[2], Derek Schaeffer[2], Christoph Niemann[2], and Dieter H. H. Hoffmann[1] — [1]Technische Universität Darmstadt, Darmstadt, Germany — [2]University of California, Los Angeles, Los Angeles, USA

The Raptor kJ class 1053 nm Nd:Glass laser in the Phoenix laser facility at University of California, Los Angeles (UCLA) in conjunction with the Large Plasma Device (LAPD), which creates a tenuous, uniform, and quiescent ambient magnetized plasma of peak plasma density of $n_i \sim 1.0\times10^{13}cm^{-3}$ and the background magnetic field varying from 200G to 1400G, provides a very unique and space-alike plasma environment. Debris ions from a carbon or polyethylene target are accelerated with super-Alfvénic speed by laser irradiation, and coupled to the ambient ions, the magnetic field background is expelled. The interaction of the debris-ambient plasma and the magnetic field creates a diamagnetic cavity, which acts as a piston launching magnetized collisionless shocks in laboratory plasma reproducing collisionless shocks observed in space. In the recent experiment at UCLA, a heated Langmuir probe has been employed to measure the electric field. Radial electric field development as well as in azimuthal direction has been investigated and its correlation with the magnetic field and ion dynamics, especially at the cavity edge, is studied. The experimental results are compared to two-dimensional hybrid simulations.

P 20.3 Mi 14:45 HZO 30

Bright subcycle XUV bursts from a single dense relativistic electron sheet — •Wenjun Ma[1], Jianhui Bin[1,2], Hongyong Wang[2,3], Mark Yeung[4,5], Christian Kreuzer[1], Peta Foster[6], Xueqing Yan[3], Bredan Dromey[4], Juergen Meyer-ter-Vehn[2], Matthew Zepf[4,5], and Joerg Schreiber[1,2] — [1]Fakultät für Physik, Ludwig-Maximilians-University, Munich, Germany — [2]Max-Planck-Institute of Quantum Optics,Garching, Germany, — [3]State Key Laboratory of Nuclear Physics and Technology, Peking University, Beijing, China, — [4]Department of Physics and Astronomy, Queen's University Belfast, Belfast, UK, — [5]Helmholtz Institute Jena, Jena, Germany, — [6]Central Laser Facility, STFC Rutherford Appleton Laboratory, Chilton, Didcot, UK

Relativistic electrons are prodigious sources of photons. Beyond classical accelerators, ultra-intense laser interactions are of particular interest as they allow the coherent motion of relativistic electrons to be controlled and exploited as sources of radiation. Here we report that bright extreme ultraviolet (XUV) radiation was generated when double foil targets separated by a low density plasma were irradiated by a PW-class laser. Simulations show that a dense sheet of relativistic electrons is formed during the interaction of the laser with the tenuous plasma between the two foils. The coherent motion of the electron sheet as it transits the second foil results in a subcycle XUV pulse, consistent with our experimental observations.

P 20.4 Mi 15:00 HZO 30

First results of laser-proton acceleration with cryogenic hydrogen targets at the POLARIS laser — •Georg Alexander Becker[1], Jens Polz[1], Anton Kalinin[3], Alexander Robinson[4], Diethard Klöpfel[1], Wolfgang Ziegler[1], Rui Costa Fraga[3], Sebastian Keppler[1], Hartmut Liebetrau[1], Alexander Kessler[2], Frank Schorcht[2], Marco Hellwing[1], Marco Hornung[2], Robert Grisenti[3], and Malte Christoph Kaluza[1,2] — [1]Institut für Optik und Quantenelektronik, Friedrich-Schiller-Universität, 07743 Jena, Germany — [2]Helmholtz Institut Jena, 07743 Jena, Germany — [3]Institut für Kernphysik, Goethe-Universität, 60438 Frankfurt am Main, Germany — [4]Central Laser Facility, Rutherford-Appleton Laboratory, Chilton, Oxon., OX11 0QX, UK

For the first time on the POLARIS laser system, a laser-driven proton acceleration experiment with cryogenic hydrogen droplets and filaments has been performed. Most laser-driven proton acceleration experiments use target materials including metals, plastics or diamond-like carbon. Due to the multitude of ion species accelerated from such targets, understanding the acceleration processes becomes quite complicated. The use of liquid or frozen hydrogen targets reduces the accelerated species to protons only and additionally produces, due to the mass limited droplets or filaments, a higher acceleration field. The experimental setup and results, including isolated monoenergetic peaks in the high energy range of the proton spectra, will be discussed.

P 20.5 Mi 15:15 HZO 30

Heating and Ionization Dynamics in Solid Density Plasmas Driven by Ultra-short Relativistic Lasers — •Lingen Huang[1], Thomas Kluge[1], Michael Bussmann[1], and Thomas Cowan[1,2] — [1]Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Bautzner Landstraße 400, D-01328 Dresden, Germany — [2]Technische Universität Dresden, D-01062 Dresden, Germany

The dynamics of heating and ionization, which determines the crucial plasma parameters such as temperature, free electron density and so on, is one of the fundamental issues in the realm of ultra-short relativistic laser-solid target interactions. We present our work on investigation of heating and ionization dynamics in solid copper target irradiated by ultra-short intense laser pulse using two dimensional particle-in-cell simulations. The simulation results show that the bulk electron temperature is very sensitive to the initial preplasma scale length. By varying the preplasma scale length from 0 to 0.08 micrometer, the bulk electron temperatures in the interest of region increase from ~26 eV to ~109 eV, which agrees very well with the theory based on Ohmic heating mechanism by treating the return current correctly. The bulk electron heating is finally translated into bulk ionization, which leads to the average Cu ion charge state increasing from ~4.3 to ~10.7.

P 20.6 Mi 15:30 HZO 30

Investigation of Warm Dense Carbon in the 100-200 GPa regime — •Jan Helfrich[1], Simon Frydrych[1], Gabriel Schaumann[1], Benjamin Barbrel[2], Jan Vorberger[3], Dirk Gericke[4], Benjamin Bachmann[5], Luke Fletcher[6], Eliseo Gamboa[6], Sebastian Göde[6], Maxence Gauthier[6], Eduardo Granados[6], Hae Ja Lee[6], Bob Nagler[6], Alessandra Ravasio[6], William Schumaker[6], Tilo Döppner[5], Roger Falcone[2], Siegfried Glenzer[6], Dominik Kraus[2], and Markus Roth[1] — [1]TU Darmstadt IKP, Germany — [2]UC Berkley, USA — [3]MPIPKS Dresden, Germany — [4]University of Warwick, UK — [5]LLNL Livermore, USA — [6]SLAC, Menlo Park, USA

The behavior of carbon under high pressure and high temperature are important for inertial confinement fusion (ICF). For fusion experiments samples with solid state densities traverses the Warm Dense Matter (WDM) region to reach the plasma state. In ICF, the ablator always contains carbon and one of the problems there is the re-freezing of the ablator carbon layer after the first shock. For the investigation of this high-pressure solid-liquid transition we used angle resolved X-ray scattering and a laser-driven shock wave to reach the WDM conditions. We compressed three different types of graphite to reach different final states with pressures up to 200 GPa. By comparing the scattering contributions from elastic to inelastic scattering we are able to determine the ion-ion structure factor. We are able to measure the ion-ion structure factor for k-values from 4.1e10 to 6.1e10 1/m. The measurements are agreed wit ab-initio DFT quantum simulations.