ILIAS - Ion and Laser beam Interaction and Application Studies

P. Mulser, Theoretical Quantum Electronics (TQE), Tech. Univ. Darmstadt, Germany
T. Schlegel, GSI, Darmstadt, Germany

Aim of the ILIAS study group

A great machine like PHELIX demands great ideas. In order to prepare an active environment for related theoretical research at GSI, the study group ILIAS has been founded in January 2005. Since the beginning its activities are directed towards fundamental as well as applied research geared to supporting the experimental projects within PHELIX and, eventually, to opening new directions in the field of superintense laser interaction with dense matter and particle beams. An additional important interest of ILIAS is focused on training young researchers to guarantee continuity of research in theoretical Petawatt (PW) physics at GSI. A detailed description of the scientific profile of the ILIAS study group is presented in [1].

Activities

The first steps towards such an ambitious goal were done during the course of the year by

- coordinating the expertises available in various groups at GSI and neighbouring Universities of Darmstadt, Frankfurt and Gießen on plasma physics, radiation hydrodynamics, atomic and nuclear physics, particle acceleration, nonlinear optics and numerical simulations;

- arranging a weekly workshop seminar, open to interested theoreticians, experimentalists and to guests from outside (ILIAS Arbeitsseminar);

- organizing a European theoretical workshop on Short Pulse PW Laser Plasma Interaction at the IBZ in Darmstadt, October 16 - 18, 2005;

- offering a lecture on Relativistic Intense Laser Interaction with Matter at TU Darmstadt.

At present, research in ILIAS is actively supported at

- GSI by T. Schlegel (radiation hydrodynamics, particle acceleration and radiation sources in laser matter interaction), M. Tomaselli (atomic and nuclear physics),

- Tech. Univ. Darmstadt by P. Mulser (collisionless absorption in clusters and solids)

- Univ. Frankfurt by J. Maruhn and Anna Tauschwitz (multidimensional hydrodynamics and applications)

- Univ. Gießen by W. Scheid (atomic physics, particle acceleration by PW laser)

Valuable support to ILIAS is given from outside:

P. Gibbon (complex atomistic modelling and simulation), Research Center Jülich; H. Ruhl (PIC and Vlasov simulations of relativistic PW laser interaction), Univ. Bochum; D. Bauer (multiphoton interaction, cluster physics), MPI Nuclear Physics, Heidelberg. H-J. Kull (laser-cluster interaction, relativistic plasma physics), RWTH Aachen.

Results

Planckian radiation sources in upcoming PHELIX experiments. The laser heated hohlraum physics is investigated and optimized for various experimental applications e.g. heavy ion stopping in hot plasmas, opacity and equation of state measurements [2].

Laser generated high energy protons and heavy ions. Further progress was achieved in understanding the laser induced acceleration of MeV proton and ion beams [3-4] .

Collective absorption mechanisms in clusters and solids. A break through in understanding the leading mechanisms of collisionless absorption in extended cluster media and in solid targets has been achieved at TU Darmstadt. The so far not explained phase shift between current density and driving electric field in the absence of friction (electron-ion collisions) is shown to happen as a consequence of the nonlinear resonance of plasma volume elements in their collective electric eigenfield [5-8]. In clusters the free electrons escaped from the core interact coherently with the Coulomb field of the individual ions thereby undergoing a giant enhancement of collision-type interaction by many orders of magnitude [8].

References

[1] P. Mulser, “ILIAS: Ion and Laser beam Interaction and Application Studies - A scientifi c portrait of the PHELIX theory group”, GSI Report 2005 - 04, June 2005

[2] E. Baldina, R. Ramis and T. Schlegel, “Multigroup kinetic description of x-ray transport in PHELIX driven hohlraums”, submitted to Phys. Rev. E

[3] E. Brambrink, A. Blazevic, M. Roth and T. Schlegel, “Modeling of the electrostatic sheath shape on the rear target surface in short-pulse laser-driven proton acceleration”, accepted by Laser and Particle Beams (2005)

[4] E.Brambrink, J.Schreiber, T. Schlegel et al., “Transverse characteristics of short pulse laser produced heavy ion beams - an approach to study the acceleration dynamics”, submitted to Phys. Rev. Letters

[5] P. Mulser, D. Bauer, “The physics of collisionless absorption of intense laser beams in solids and clusters”, Varenna 2005, accepted by Proc. Am. Inst. Phys.

[6] P. Mulser, M. Kanapathipillai, “Collisionless absorption in clusters out of linear resonance”, Phys. Rev. A 71, (2005) 063201

[7] D. Bauer, P. Mulser, “Irreversible energy gain by linear and nonlinear oscillations”, Journal of Physics, Conf. Series 11, (2005) 169

[8] P. Mulser, M. Kanapathipillai, and D.H.H. Hoffmann, “Two very effi cient nonlinear laser absorption mechanisms in clusters”, Phys. Rev. Letters 95, (2005) 103401