APPLIED & ENGINEERING PHYSICS

Physics of High Energy Density

Allocation : 2 + 2 **Year / Semester :** 2 - 3 / Fall **Lecturer :** L. Drska

Objectives / Prerequisites

1. Objectives : The course offers an up-to-date survey of physics of systems with extreme parameters (density, temperature, field intensity) as a starting point to the research in this area. 2. Prerequisites : Sound previous knowledge of plasma physics and nuclear physics is expected,reasonable proficiency and skills in scientific computing are essential.

Short Syllabus

1. Introduction : High Energy Density Physics. Definition of High Energy Density Physics (HEDP). High Energy Density Systems (HEDS) in Nature and laboratory. Classical, quantum and relativistic HEDS. Radiative and nucleoreactive systems. 2. Theory / Simulation in HEDP. Problems of the theory of HEDS, strongly coupled systems and superstrong fields. Concepts and limits of theoretical descriptions of HEDS. Key role of computational approaches, simulation concepts and demands. Warm dense plasma, high-field systems, inertial confinement fusion, astrophysical systems. Description and simulation of systems with radiative and nuclear processes. 3. Experiments / Diagnostics in HEDP. State-of-the-art facilities to create HEDS. Pulsed systems, beam-driven systems, superintense lasers, XFEL facilities, multidriver concepts. A survey of available diagnostic tools for HEDS. The value of simulations in experiment design and diagnostic evaluation. Problems of the diagnostics of rare processes in HEDS, novel data evaluation approaches. 4. Applications of HEDP / HED Technologies. HEDP as a base for new high-tech applications. Special and intense radiation sources, nuclids production, potential use in ADTT. Conventional and non-conventional / exotic ways to fusion energy, non-neutronic systems. Laboratory high-energy-density astrophysics, experimental relativistic and nuclear astrophysics. 5. Conclusion : Potential Trends in HEDP. HEDP tasks for future intensive computing facilities. Physics of superdense and ultrahot states of matter. Gamma lasers, modification of nuclear processes. Future HEDS and particle physics.

Sample References

[1] Eliezer S.: *The Interaction of High-Power Lasers with Plasma*. Institute of Physics Publishing 2002. ISBN 0-7503-0747-1 - [2] Gibbon P.: *Short Pulse Laser Interactions with Matter : An Introduction.* Imperial College Press 2005. ISBN 1-86094-135-4 - [3] Kremp D., Schlanges M., Kraeft W.-D.: *Quantum Statistics of Nonideal Plasmas.* Springer 2005. ISBN 3-540-65284-1 - [4] Ichimaru S.: *Statistical Plasma Physics. Vol. 2. Condensed Plasmas*. Addison-Wesley 1994. ISBN 0-201-55491-7 - [5] Drake R.P.: *High-Energy-Density Physics: From Inertial Fusion to Experimental Astrophysics.* Springer 2006. ISBN 3-540-29314-0 - [6] Atzeni S., Meyer-ter-Vehn J.: *The Physics of Inertial Fusion: Beam-Plasma Interaction, Hydrodynamics, Hot Dense Matter.* Oxford Science Publications 2004. ISBN 0-19-856264-0 - [7] Schwoerer H., Magill J., Beleites B. (Eds.) : *Lasers and Nuclei: Applications of Ultrahigh Intensity Lasers in Nuclear Science.* Springer 2006. ISBN 3-540-30271-9.

Examen Information

1. Microproject : Realization and presentation of an individual small research project in the area of HEDP (70%) . 2. Final examen : Solution of a relevant problem and discussion (30%)

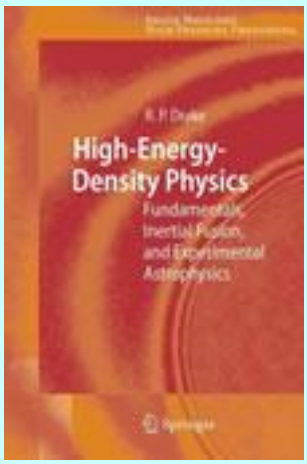
Physics of High Energy Density

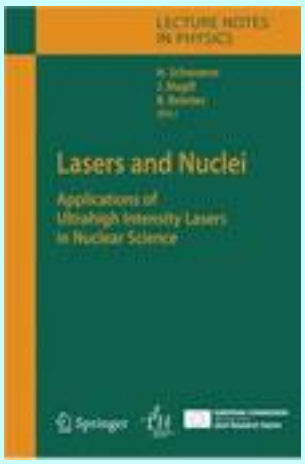
TOP 3+2

Drake R.P.:
High-Energy-Density Physics:
Fundamentals, Inertial Fusion, and Experimental Astrophysics.
Springer 2006
ISBN 3-540-29314-0 Chap. 1, **3**, **6**, 8, 9, **10**

Atzeni S., Meyer-ter-Vehn J.:
The Physics of Inertial Fusion:
Beam Plasma Interactions, Hydrodynamics, Hot Dense Matter.
Oxford University Press 2004
ISBN 0-19-856264-0 Chap. **1**, 2, 3, 9,**10**,**11**

Schwoerer H., Magill J., Beleites B. (Eds):
Lasers and Nuclei:
Applications of Ultrahigh Intensity Lasers in Nuclear Science.
Springer 2006
ISBN 3-540-30271-9 Chap. **2**, **3**, 6, 7, 8, **13**





Mourou G.A., Tajima T., Bulanov S.V.:
Optics in the Relativistic Regime.
Reviews of Modern Physics **76**, April – June 2006, 309 - 371
0034-6861/2006/78(2)/309(63)
http://rmp.aps.org/

Remington B.A., Drake R.P., Ryutov D.D.:
Experimental Astrophysics with High Power Lasers and Z Pinches.
Reviews of Modern Physics **76**, July – September 2006, 755 - 807
0034-6861/2006/78(3)/755(53)
http://rmp.aps.org/