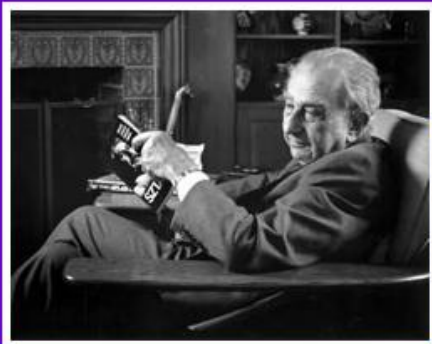


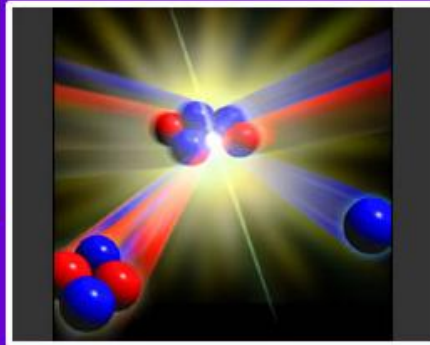
FNSPE CTU

APPLIED & ENGINEERING PHYSICS

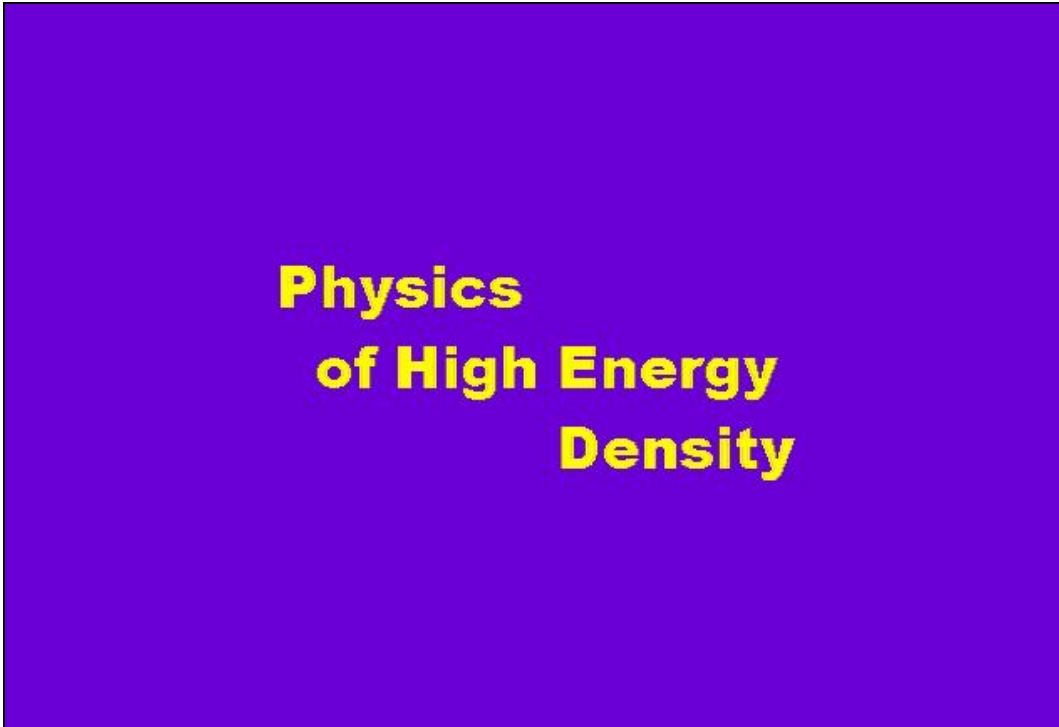
COURSES



Edward Teller 1908 - 2003



Applied and Engineering Physics
Faculty of Nuclear Sciences and Physical Engineering, CTU Prague



**Physics
of High Energy
Density**

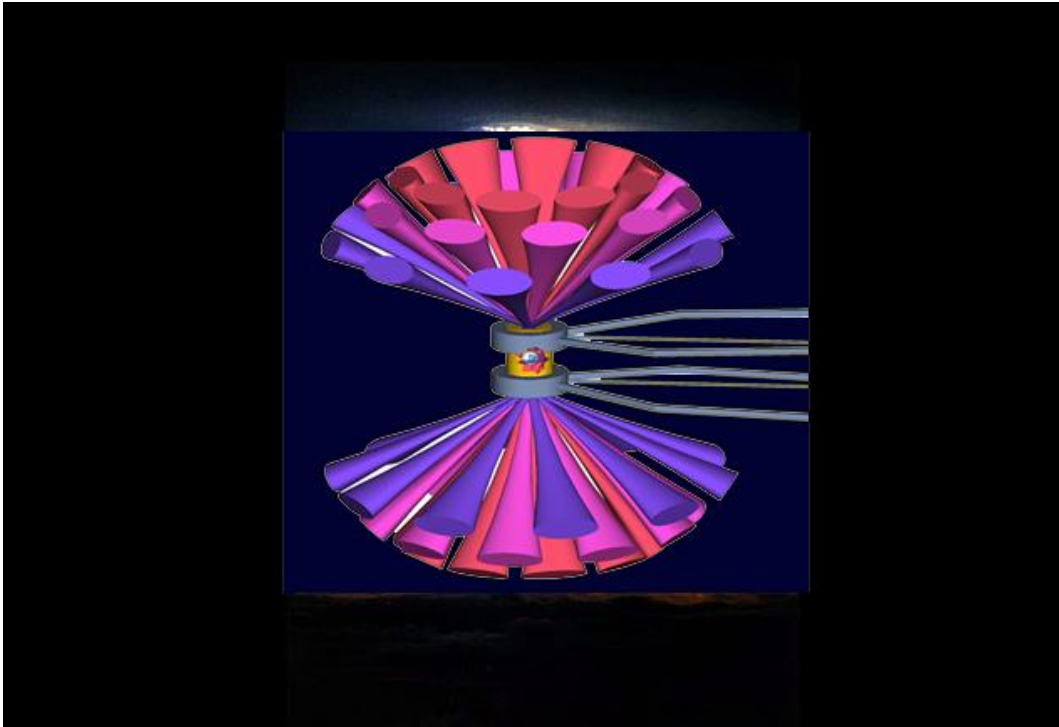




Course
Physics of High Energy Density
Year : Second / Third
Semester : Fall

Staff
Lectures : Prof. Ladislav Drska
Projects : Prof. Ladislav Drska et al.

Course Meeting Times
Lectures : 2 hours / week
Laboratory : 2 hours / week





Course Concepts

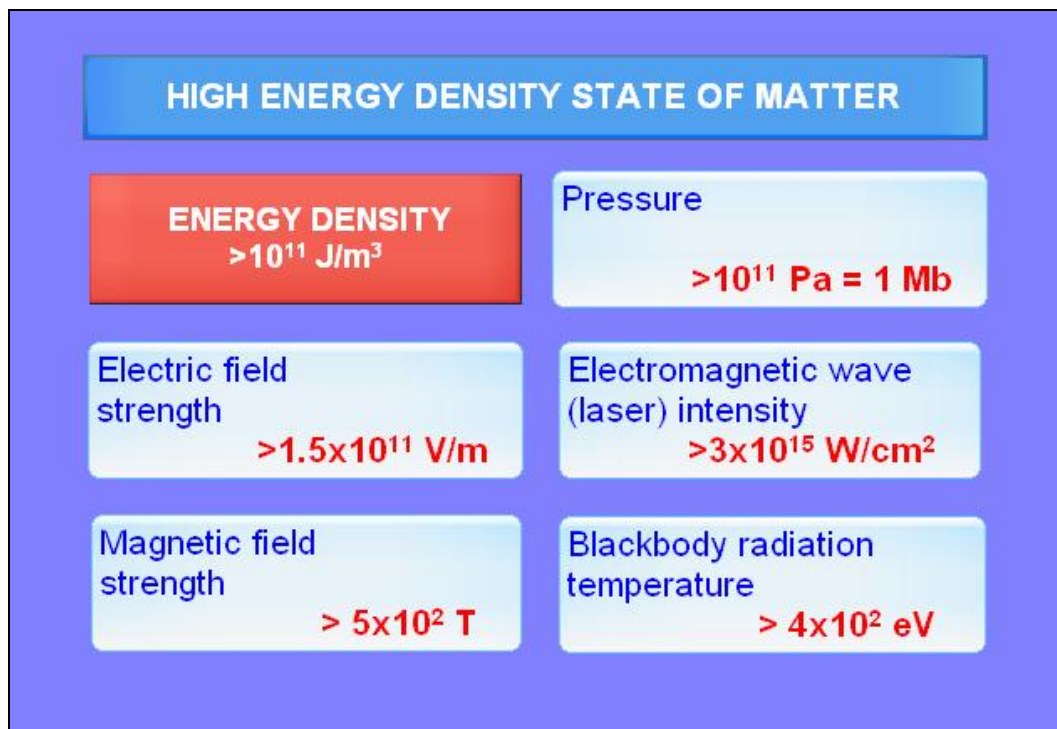
Course Objectives / Prerequisites

>>> 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.

>>> Prerequisites >>>


Sound previous knowledge of plasma physics and nuclear physics is expected, reasonable proficiency and skills in scientific computing are essential.



HIGH ENERGY DENSITY STATE OF MATTER

ENERGY DENSITY

Material	Energy Density (J / cm^3)
HEDS	$>10^5$
SEMTEX 1A	7.22×10^3



Course Outline (1)

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.

Course Outline (2)

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

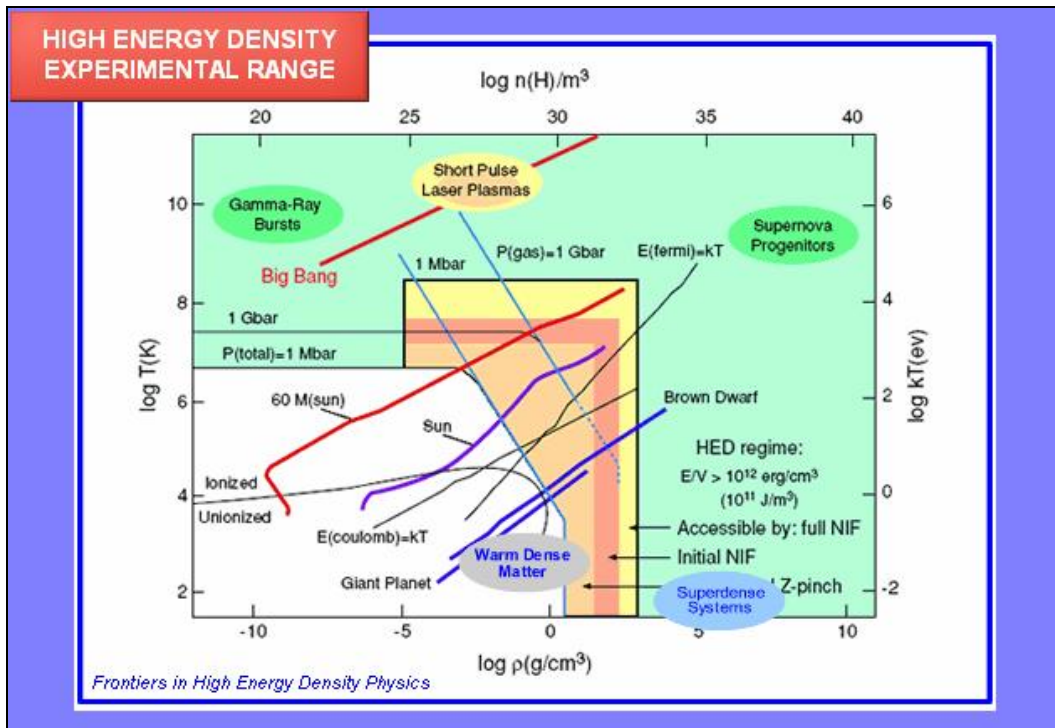
HEDP as a base for new high-tech applications. Special and intense radiation sources, nuclids production, potential use in ADTT. Conventional and non-conventional / exotic ways to fusion energy, non-neutronic systems. Laboratory high-energy-density astrophysics, experimental relativistic and nuclear astrophysics.

Course Outline (3)

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

7. References : Texts / Databases / Webpages



Course Features / Exam

>>> Features >>>

The course is presented in *Twin-Learning Mode*, its substantial part is delivered in a computational laboratory; an individual research project must be carried out.

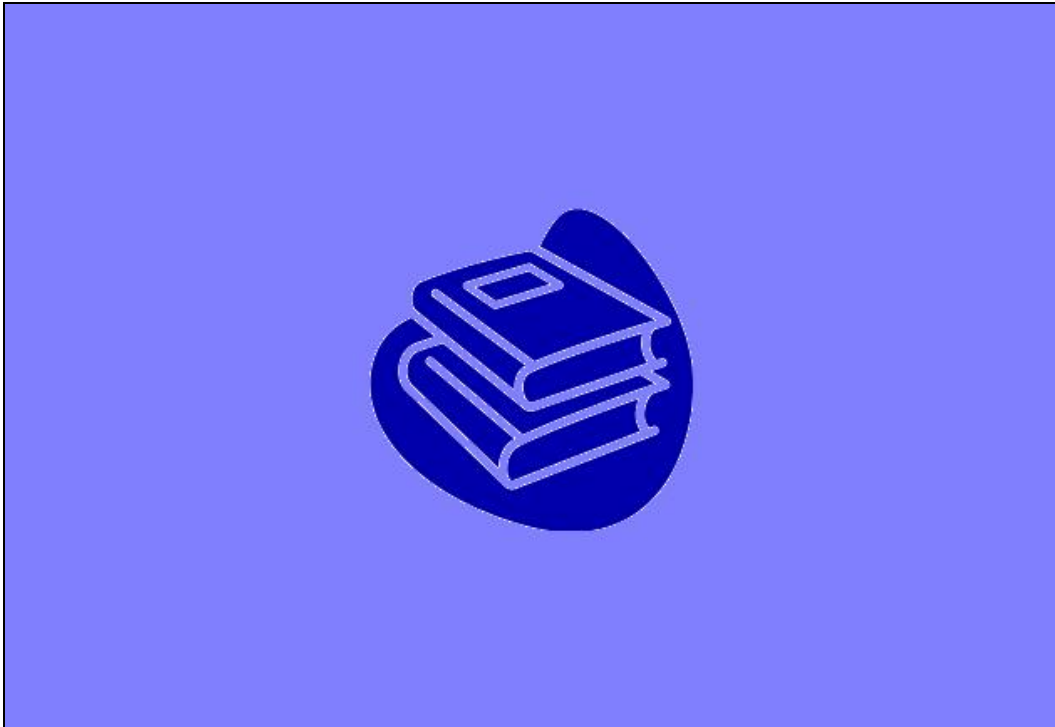
>>> Exam / Grading >>>

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





Course Resources



Classics

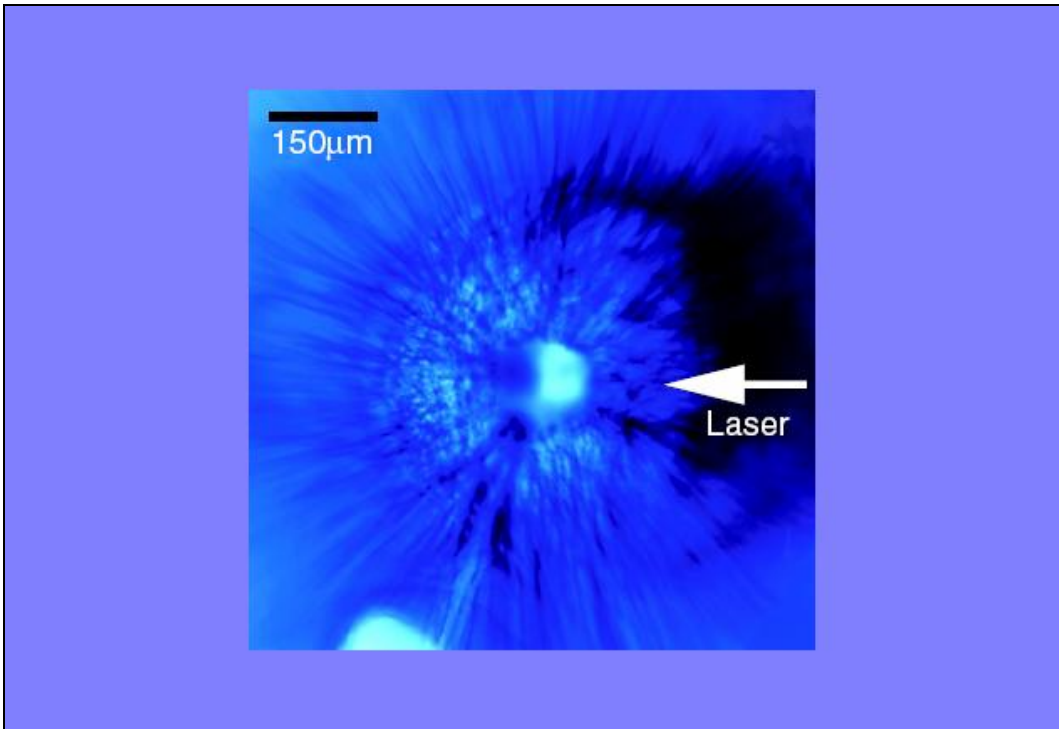
[01] Caldirola P., Knoepfel H. (Editors):
Physics of High Energy Density. Proceedings
of the International School of Physics
"Enrico Fermi", Varenna on Lake Como,
July 14 - 26, 1969.
Academic Press 1991.
ISBN 0-12-368848-5

[02] Zel'dovich Ya.B., Raizer Yu.P.:
**Physics of Shock Waves and High-Temperature
Hydrodynamic Phenomena**. Translation / Paperback.
Dover Publications 2002.
(Original Edition : Nauka 1966)
ISBN 0486420027

[03] Clayton D.D.:
Principles of Stellar Evolution and Nucleosynthesis.
Reprint Edition.
University of Chicago Press 1984.
(Original Edition : McGraw Hill 1968)
ISBN 0-226-10953-4

[03a] Rolfs C.E., Rodney W.S.:
Cauldrons in the Cosmos : Nuclear Astrophysics.
University of Chicago Press 2005.
ISBN 0-226-72457-3

The image shows three book covers. The top cover is 'Physics of High Energy Density' with a dark blue background and white stars. The middle cover is 'Physics of Shock Waves and High-Temperature Hydrodynamic Phenomena' with a red background and white text. The bottom cover is 'Principles of Stellar Evolution and Nucleosynthesis' with a red background and a diagram of a star's internal structure.



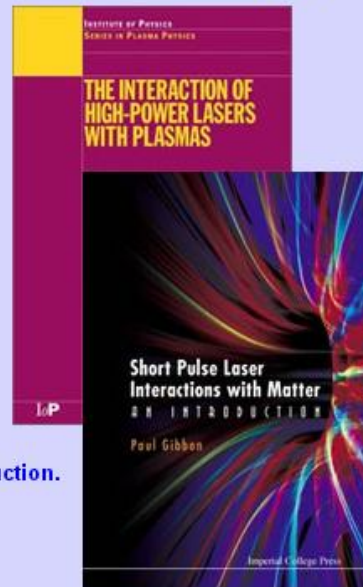
Top Twelve References (1)

[01] Eliezer S.:
The Interaction of High-Power Lasers with Plasma.
 Institute of Physics Publishing 2002.
 ISBN 0-7503-0747-1

[02] Salzman D.:
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 Oxford University Press 1998
 ISBN 0-19-510930-9

[03] Beyer F.H., Shevelko V.P.:
Introduction to the Physics of Highly Charged Ions.
 Institute of Physics Publishing 2003
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[04] Gibbon P.:
Short Pulse Laser Interactions with Matter : An Introduction.
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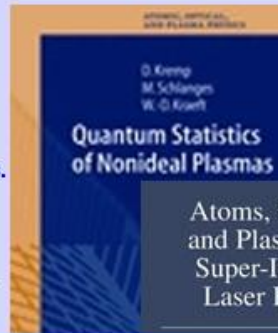
Top Twelve References (2)

[05] Kremp D., Schlanges M., Kraeft W.-D.:
Quantum Statistics of Nonideal Plasmas.
 Springer 2005.
 ISBN 3-540-65284-1

[06] Ichimaru S.:
Statistical Plasma Physics. Vol. 2. Condensed Plasmas.
 Addison-Wesley 1994.
 ISBN 0-201-55491-7

[07] Batani D., Joachain Ch.J., Martellucci S., Chester A.N.
 (Editors):
**Atoms, Solids, and Plasmas in Super-Intense
 Laser Fields.**
 Kluwer Academic / Plenum Publishers 2001.
 ISBN 0-306-46615-5

[08] Schwoerer H., Magill J., Beileites B. (Editors):
Lasers and Nuclei. Applications of Ultra-High Intensity
 Lasers in Nuclear Science.
 Springer 2006.
 ISBN 3-540-30271-9



Atoms, Solids,
 and Plasmas in
 Super-Intense
 Laser Fields

[08a] Galy J., Zhagar T., Magill J., Schwoerer H.
 (Editors):
**International Workshop on Lasers &
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 Lasers in Nuclear Science, Karlsruhe,
 September 13 - 15, 2004 (CD).
 European Commission, Joint Research Centre
 2004.
 S.P.K. 04.173

Sergio Martellucci, and Arthur N. Chester

Top Twelve References (3)

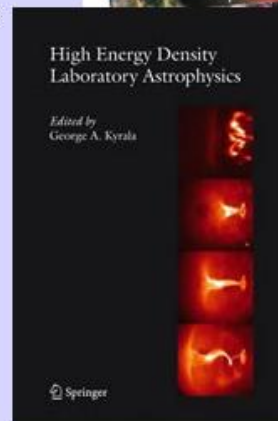
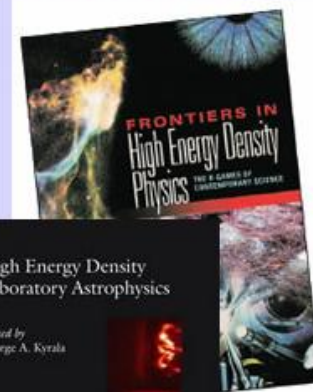
[09] Atzeni S., Meyer-ter-Vehn J.:
The Physics of Inertial Fusion: Beam-Plasma Interaction,
 Hydrodynamics, Hot Dense Matter.
 Oxford Science Publications 2004.
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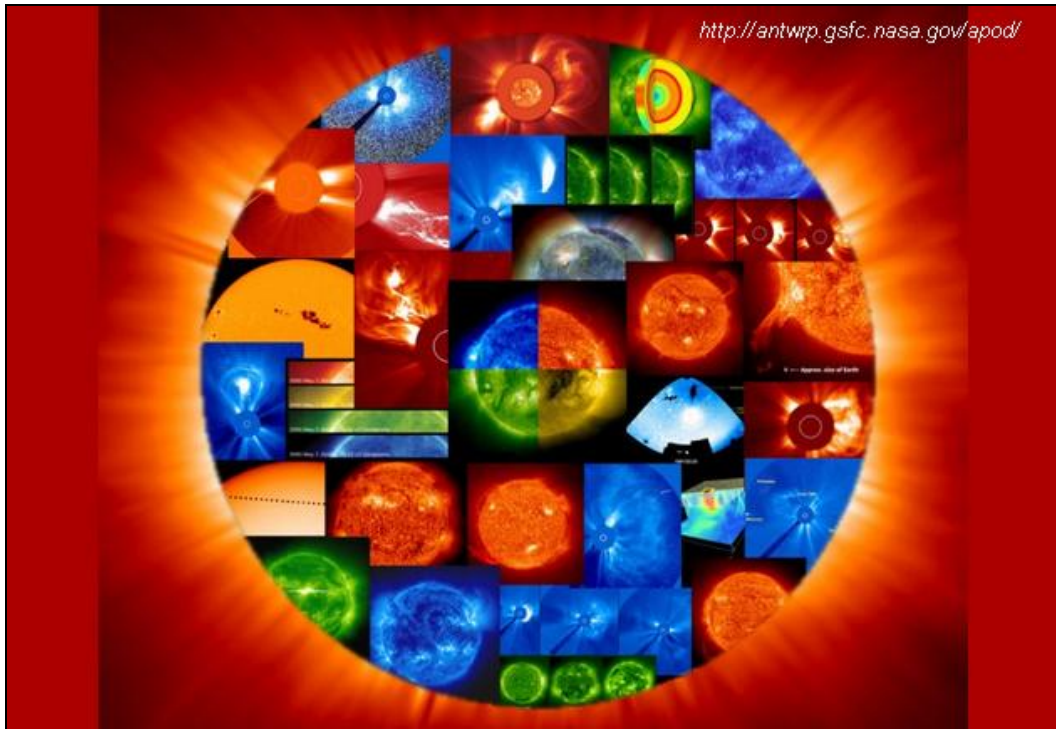
**Chap. 1. Nuclear
 Reactions**

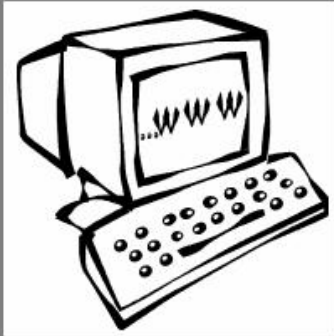
[10] Committee of High Energy Density Plasma Physics,
 Plasma Science Committee, National Research Council:
Frontiers in High Energy Density Physics : The X-Games
 of Contemporary Science.
<http://books.nap.edu/catalog/10544.html>
 The National Academies Press 2003

[11] Drake R.P.:
High-Energy-Density Physics: From Inertial Fusion
 to Experimental Astrophysics.
 Springer 2006.
 ISBN 3-540-29314-0

[12] Kyrala G.A. (Ed.):
High Energy Density Laboratory Astrophysics.
 Springer 2005.
 ISBN 1-4020-3483-0







Some Webpages (1)

[01] **PALS: Laser Plasma Centre.**
<http://www.clp.cas.cz/>

Live URLs

[02] **LLNL: Lawrence Livermore National Laboratory,** University of California
<http://www.llnl.gov/>

[03] **LLE: Laboratory for Laser Energetics,** University of Rochester
<http://www.lle.rochester.edu/index.html>

[04] **CLF: Central Laser Facility,** Rutherford Appleton Laboratory
<http://www.clf.rl.ac.uk/>

[05] **Center for Ultrafast Optical Science,** University of Michigan
<http://www.eecs.umich.edu/CUOS/>

<http://www.llnl.gov/>

Some Webpages (2)

- [06] **LOA : Laboratoire d'Optique Appliquée**, ENSTA / École Polytechnique
http://www.ensta.fr/loa/index_gb.html Live URLs
- [07] **GSI: Gesellschaft fuer Schwerionenforschung**, Helmholtz-Gemeinschaft
<http://www.gsi.de/>
- [08] **HASYLAB : Hamburger Synchrotronstrahlungslabor**
<http://www-hasylab.desy.de/main.shtml>
- [09] **XFEL : The European X-Ray Laser Project**
<http://www.xfel.net/en/>
- [10] **JINA : The Joint Institute for Nuclear Astrophysics**
<http://www.jinaweb.org/>

J I N A



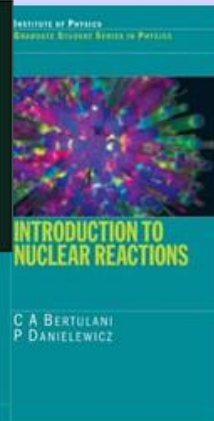
Supplementary Refs for Projects (1)

[01] Nikiforov A.F., Novikov V.G., Uvarov V.B., Iacob A.:

Quantum-Statistical Models of Hot Dense Matter: Methods for Computation Opacity and Equation of State.
 Birkhauser 2005.
 ISBN 3-7643-2183-0

[02] Bertulani C.A., Danielewicz P.:
Introduction to Nuclear Reactions.
 Institute of Physics Publishing 2004
 ISBN 0-7503-0932-6

[03] Magill J., Galy J.:
Radioactivity, Radionuclides, Radiation.
 Springer 2005.
 ISBN 3-540-21116-0



Supplementary Refs for Projects (2)

[04] Arnett D.:

Supernovae and Nucleosynthesis. Paperback
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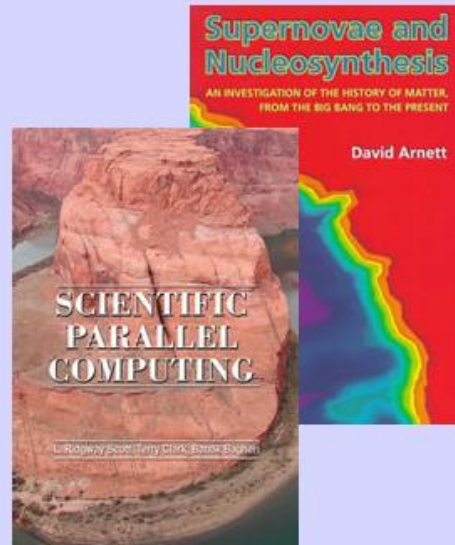
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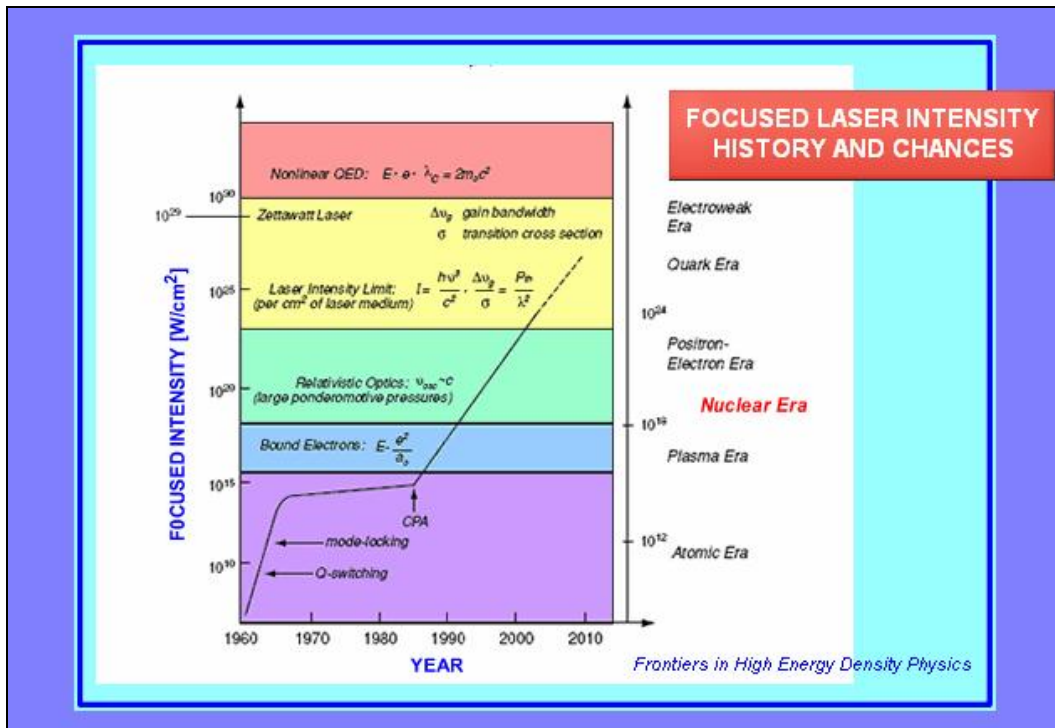
**Numerical and Analytical Methods for Scientists
and Engineers using Mathematica.**
Wiley 2003.
ISBN 0-471-26610-8

[06] Scott L.R., Clark T., Bagheri B.:

Scientific Parallel Computing.
Princeton University Press 2005.
ISBN 0-691-11935-X

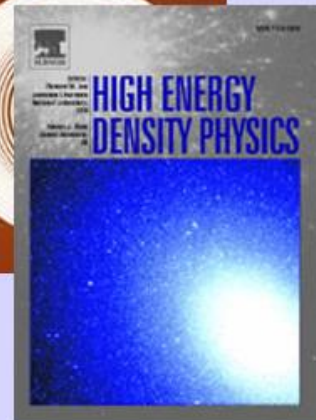
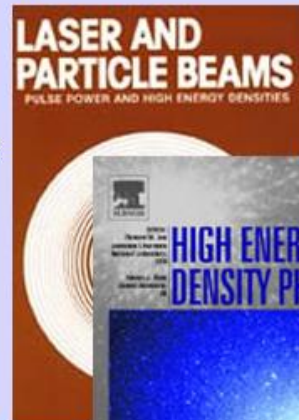
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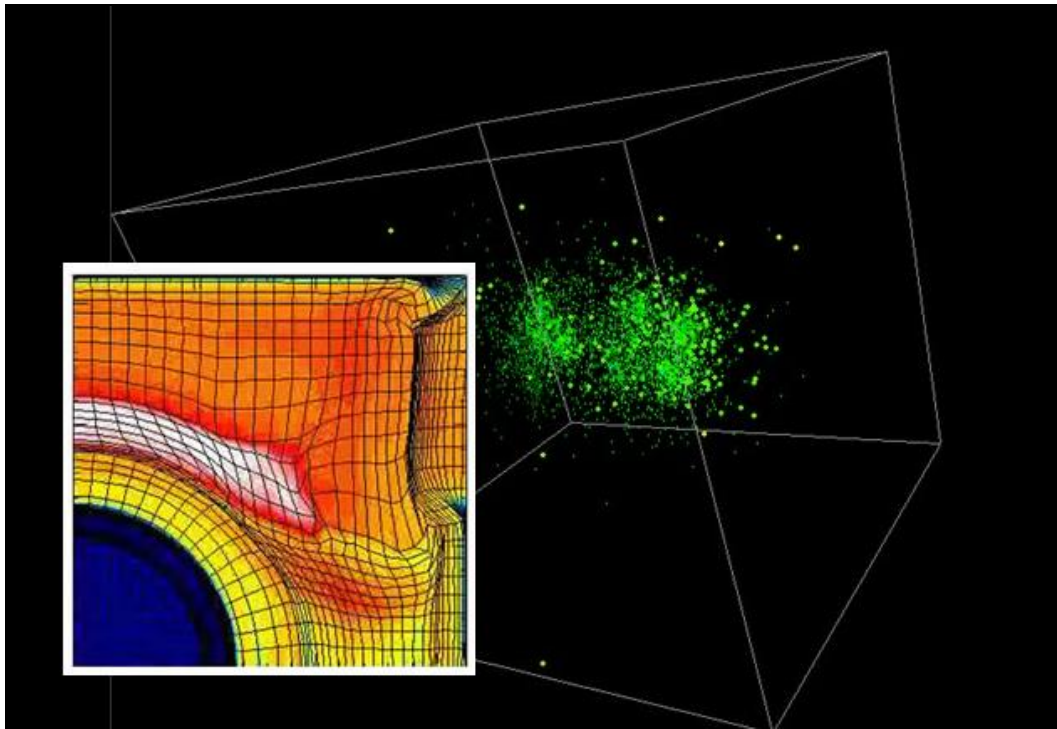




Live URLs

- [1] **Laser and Particle Beams.**
Cambridge University Press.
ISSN 0263-0346
<http://journals.cambridge.org/action/displayJournal?jid=LPB>
- [2] **High Energy Density Physics.**
Elsevier.
ISSN 1574-1818
<http://www.sciencedirect.com/science/journal/15741818>
- [3] **Physics of Plasmas.**
American Institute of Physics.
ISSN 1070-664X (Print + Online)
ISSN 1089-7674 (Online only)
<http://pop.aip.org/pop/>

Special Journals





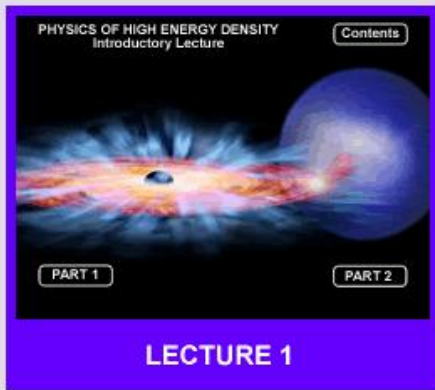
Extented Syllabus



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Sample Lecture

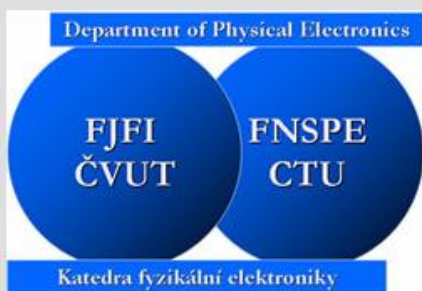


>>>> Please <<<<<
CLICK THE PICTURE

Thank you for your attention

Comment and suggestions are
welcome
drska@antu.fjfi.cvut.cz





School of Applied and
Engineering Physics

Creator of the movie : L. Drska

