VW Plasma Physics course

TU Dresden
Lecturer: Dr. Katerina Falk

Summer semester: April – July 2022

Time: Friday, 2 DS (9:20 – 10:50)
Duration: 1 DS (1.5 hours)
Location: ASB/328/H

Course description:

This course provides a detailed description of the basic principles in Plasma Physics including the charge shielding, propagation of electromagnetic radiation on plasmas, waves in plasma, thermodynamic and electromagnetic properties, an introduction to kinetic theory and basic magneto-hydrodynamics. It also gives an overview of applications of Plasma Physics such as fusion energy, astrophysical plasmas and laboratory astrophysics, plasma x-ray spectroscopy, and plasma accelerators. It should serve as a good pre-requisite or complementary course to the Physics of Particle Accelerators taught by Prof. U. Schramm. The contents is suitable for advanced bachelor students, Masters and PhD students with no background in Plasma Physics. The lecture course also includes guest lectures on Laboratory Astrophysics, X-ray spectroscopy and Particle-in-cell (PIC) simulations. This course is fully credited and counts towards qualification requirements for PhD students.

All materials (incl. recorded lectures) for the course are available online on OPAL and on the HZDR website listed below. If you wish to attend the course, please email the lecturer to enroll: k.falk@hzdr.de.

Previous knowledge:

Electromagnetism, thermodynamics, statistical mechanics, basic atomic physics

Language: English

Website (course information and material):

https://www.hzdr.de/db/Cms?pOid=63014&pNid=917 (Password: TUD_plasma)

TU Dresden course catalogue:

https://tu-dresden.de/mn/physik/studium/lehrveranstaltungen/KVVLesFullext.php?year=2022&lang=E&var=983

OPAL online teaching platform (TU Dresden) – also includes course material:

https://bildungsportal.sachsen.de/opal/auth/RepositoryEntry/34102607874;jsessionid=082C88B24A83DCB61E1774984939EE6B.opalN4?0

Lecture schedule plan:

1)	**Fri, April 8, 2022**	**Basic plasma parameters and definitions**
Definition of plasma, Saha equation, plasma parameter, Debye length, plasma frequency		

	Fri, April 15, 2022	**NO lecture**
Easter vacation		

2)	**Fri, April 22, 2022**	**Single particle motion in plasma**
Larmor orbits, guiding centre drift, gradient drift, mag. mirrors		
3)	**Fri, April 29, 2022**	**Collisions and radiation (recorded)**
Particle scattering, Coulomb logarithm, Bohm-Gross frequency, resistivity		
4)	**Fri, May 6, 2022**	**Kinetic theory**
Distribution functions, Vlasov equation, Langmuir waves, Landau damping		
5)	**Fri, May 13, 2022**	**Magneto-hydrodynamics (macroscopic model)**
MHD equations, magnetic flux freezing, magnetic pressure and plasma beta		
6)	**Fri, May 20, 2022**	**Waves in plasma I**
Plasmons, sound waves, ion acoustic waves, Alfvén waves, dielectric tensor		
7)	**Fri, May 27, 2022**	**Waves in plasma II**
Waves in magnetized plasma, Whistler, O, X-modes, Alfvén waves revisited		
8)	**Fri, June 3, 2022**	**Magnetic confinement and fusion**
Tokamaks, stellarators, Z-pinches, magnetic instabillities		
	Fri, June 10, 2022	**NO lecture**
Pentecost (no lecture period)		
9)	**Fri, June 17, 2022**	**Laser plasmas & ICF**
Inverse Bremsstrahlung, ablation model, ICF implosion, direct/indirect drive, fast ignition		
10)	**Fri, June 24, 2022**	**Plasma instabilities**
Resonance absorption, B-fields, parametric instabilities		
11)	**Fri, July 1, 2022**	**Plasma shocks**
Rankine-Hugoniot relations, collisionless shocks, etc.		
14)	**Fri, July 8, 2022**	**X-ray plasma spectroscopy (Dr. Michal Šmíd)**
Guest lecture		
15)	**Fri, July 15, 2022**	**Plasma simulations (Dr. Michael Bussmann)**
Guest lecture		
Bonus lecture (recorded)		**Astrophysical plasmas and Lab Astro (Prof. Hideaki Takabe)**
Guest lecture		

Recommended literature:

- A. Piel: **Plasma Physics**, Springer
- F. F. Chen: **Introduction to Plasma Physics and Controlled Fusion**, Springer
- R. O. Dendy: **Plasma Dynamics**, Oxford Science Publications
- D. H. Trevena: **Statistical Mechanics**, Horwood Publishing
- R. P. Drake: **High Energy Density Physics**, Springer
- W. L. Kruer: **The Physics Of Laser Plasma Interactions**, Westview Press
- T. Tajima & K. Shibata: **Plasma Astrophysics**, Westview Press