

Nonlinear Optics

WiSe 2018-2019

Prof. Franz X. Kärtner & Dr. Oliver D. Mücke, Bldg. 99, Room O3.111 & O3.115

Email & phone: franz.kaertner@cfel.de, 040 8998 6350

oliver.muecke@cfel.de, 040 8998 6355

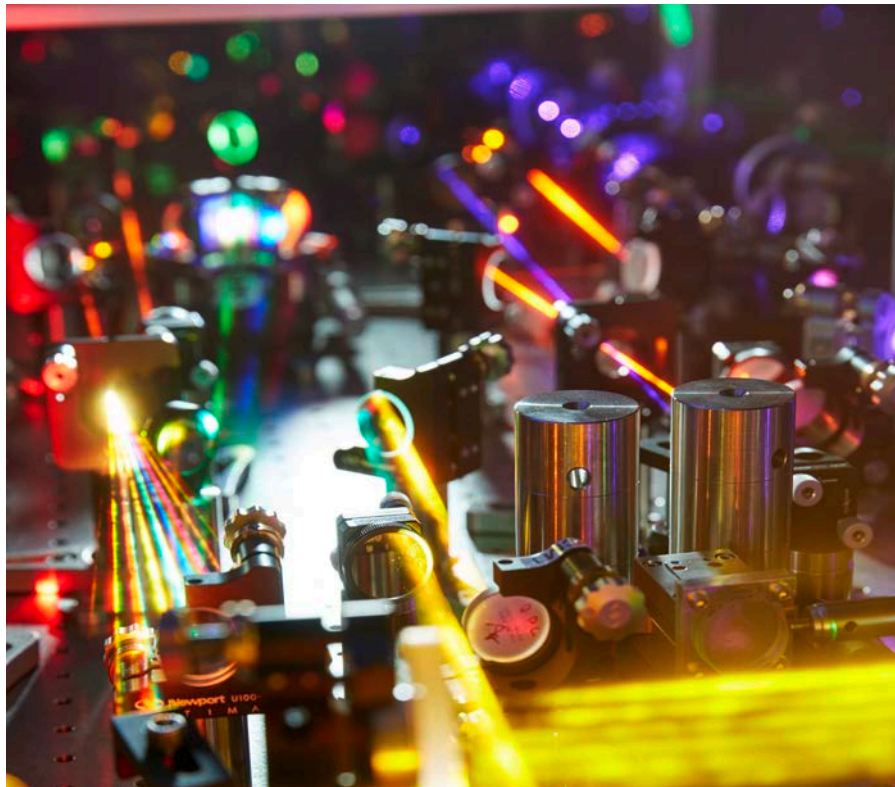
Lectures: Fr 08:30-10:00 and 10:15-11:00, SemRm 4, Jungiusstr. 9

Recitations: Fr 11:15-12:00, SemRm 4, Jungiusstr. 9

Start: October 19, 2018

Content:

Nonlinear optical susceptibilities and symmetries, nonlinear wave equation, second-harmonic generation, phase matching, quasi-phase matching, optical rectification, Manley-Rowe relations, sum- and difference-frequency generation, THz generation, optical parametric amplification, ultrashort-pulse optical parametric (chirped-pulse) amplification, third-order nonlinear effects: third-harmonic generation, Kerr effect, self-phase modulation, self-focusing, stimulated Raman- and Brillouin-scattering, optical solitons, extreme nonlinear optics: carrier-wave Rabi flopping, Bloch oscillations, dynamical Franz-Keldysh effect, strong-field physics in solids, high-harmonic generation, high-order sideband generation, attosecond science: RABBITT, attosecond streaking, transient XUV absorption.



Required Textbook: Class notes will be distributed in class.

Recommended Textbook: *Nonlinear Optics*, R. W. Boyd, Academic Press, Third Edition (2008).

Additional References:

1. *The Principles of Nonlinear Optics*, Y. R. Chen, J. Wiley & Sons NY (1984).
2. *The Elements of Nonlinear Optics*, P. N. Butcher & D. Cotter, Cambridge Studies in Modern Optics 9 (1990).

3. *Nonlinear Fiber Optics*, G. P. Agrawal, Academic Press (1998).
4. *Solitons: an introduction*, P. G. Drazin & R. S. Johnson, Cambridge Texts In Applied Mathematics, NY (1989).
5. *Fundamentals of Attosecond Optics*, Z. Chang, CRC Press (2016).
6. *Attosecond and Strong-Field Physics*, C. D. Lin, A.-T. Le, C. Jin, and H. Wei, Cambridge University Press (2018).
7. *Extreme Nonlinear Optics*, M. Wegener, Springer (2005).

Requirements:

9 Problem Sets and a Term Paper
 Collaboration on problem sets is encouraged.

Course Policy:

Collaboration: Collaboration on problem sets is permitted. However, you must list who you collaborated with, when you hand in your problem sets. Groups may discuss the problems, strategies for solutions, etc. However, each person is expected to do all of the problems independently. You may not copy the problem solutions from other members in your group. Evidence of copying will be considered cheating.

Plagiarism: Direct copying of text from other sources (books, review articles, etc.) on the term papers will be considered plagiarism. Reproduction of figures or data is permitted provided that the reference is cited.

Tentative Schedule:

1	Franz Kärtner 19/10/2018	Introduction to Nonlinear Optics
2		Important Nonlinear Optical Processes Overview
3	Oliver Mücke 26/10/2018	Nonlinear Optical Susceptibilities <i>Problem Set 1 Out</i>
4		Susceptibility Tensors
5	Franz Kärtner 2/11/2018	Nonlinear Wave Equation <i>Problem Set 1 Due, Problem Set 2 Out</i>
6		Second-Harmonic Generation
7	Oliver Mücke 9/11/2018	Frequency Doubling of Pulses, Quasi-Phase Matching <i>Problem Set 2 Due, Problem Set 3 Out</i>
8		Optical Parametric Oscillation/Amplification, Difference Frequency Generation
9	Franz Kärtner 16/11/2018	Electro-Optic Effect and Modulators <i>Problem Set 3 Due, Problem Set 4 Out</i>
10		Acousto-Optic Modulators and Bragg Cells
11	Franz Kärtner 23/11/2018	Third-Order Nonlinear Effects <i>Problem Set 4 Due, Problem Set 5 Out</i>
12		Self-Phase Modulation and Self-Focusing

13	Franz Kärtner 30/11/2018	Raman and (Stimulated) Brillouin Scattering <i>Problem Set 5 Due, Problem Set 6 Out; Distr. Term Paper Proposals</i>
14		Optical Solitons
15	Oliver Mücke 7/12/2018	Ultrashort-Pulse Optical Parametric Amplification <i>Problem Set 6 Due, Problem Set 7 Out</i>
16		Ultrashort-Pulse Optical Parametric Chirped-Pulse Amplification
17	Oliver Mücke 14/12/2018	High-Energy Few-Cycle Parametric Sources I <i>Problem Set 7 Due, Problem Set 8 Out</i>
18		High-Energy Few-Cycle Parametric Sources II: NOPA, OPCPA, passive CEP stabilization in OPA
19	Oliver Mücke 21/12/2018	Nonlinear Optics with Two-Level Systems <i>Problem Set 8 Due, Term Paper Proposal Due</i>
20		Carrier-Wave Rabi Flopping
21	Franz Kärtner 11/1/2019	Ultrafast Terahertz (THz) Sources <i>Problem Set 9 Out</i>
22		Applications of Ultrafast Terahertz (THz) Sources
23	Oliver Mücke 18/1/2019	High-Harmonic Generation <i>Problem Set 9 Due</i>
24		Attosecond Science
25	Oliver Mücke 25/1/2019	Strong-Field Physics in Solids I
26		Strong-Field Physics in Solids II
27	--	Term Paper Presentation
28		Term Paper Presentation