Nonlinear Optics

WiSe 2016-2017

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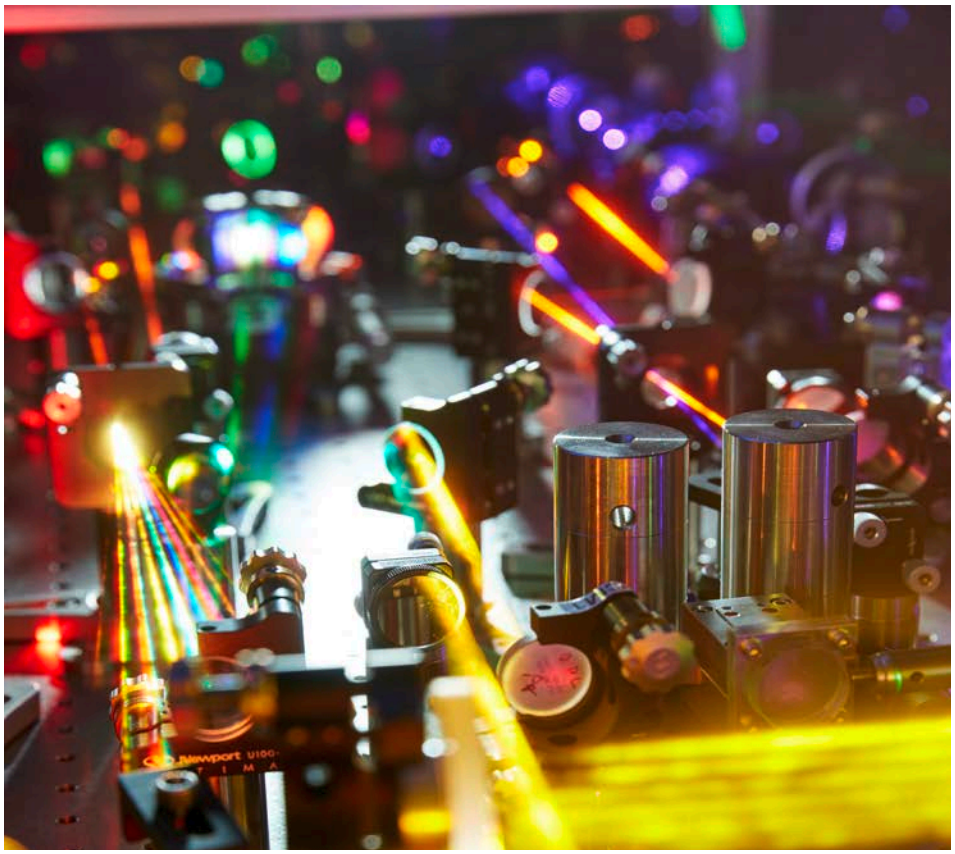
Lectures: Fr 09.00-11.15 - **Recitations:** Fr 11.45-12.30
Start: October 21, 2016
Location changed to: Campus Bahrenfeld, bldg. 99, SR I as of Oct. 28.

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-order harmonic generation, attosecond science.



Required Textbook: Class notes will be distributed in class.
Recommended Textbook: R. W. Boyd, Nonlinear Optics.

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).

Requirements:

10 Problem Sets and 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 21/10/2016	**Introduction to Nonlinear Optics**
2		**Important Nonlinear Optical Processes Overview**
3	Franz Kärtner 28/10/2016	**Nonlinear Optical Susceptibilities** *Problem Set 1 Out*
4		**Susceptibility Tensors**
5	Oliver Mücke 04/11/2016	**Nonlinear Wave Equation** *Problem Set 1 Due, Problem Set 2 Out*
6		**Second-Harmonic Generation**
7	Oliver Mücke 11/11/2016	**Frequency Doubling of Pulses, Quasi-Phase Matching** *Problem Set 2 Due, Problem Set 3 Out*
8		**Optical Parametric Oscillation/Amplification, Difference Frequency Generation**
9	Franz Kärtner 18/11/2016	**Electro-Optic Effect and Modulators** *Problem Set 3 Due, Problem Set 4 Out*
10		**Acousto-Optic Modulators and Bragg Cells**
11	Franz Kärtner 25/11/2016	**Third-Order Nonlinear Effects** *Problem Set 4 Due, Problem Set 5 Out*
12		**Self-Phase Modulation and Self-Focusing**
13	Oliver Mücke 02/12/2016	**Raman and (Stimulated) Brillouin Scattering** *Problem Set 5 Due, Problem Set 6 Out; Distr. Term Paper Proposals*
14		**Optical Solitons**

15	Franz Kärtner 09/12/2016	**Ultrashort-Pulse Optical Parametric Amplification** *Problem Set 6 Due, Problem Set 7 Out*
16		**Ultrashort-Pulse Optical Parametric Chirped-Pulse Amplification**
17	Oliver Mücke 16/12/2016	**High-Energy Few-Cycle Parametric Sources I** *Problem Set 7 Due, Problem Set 8 Out*
18		**High-Energy Few-Cycle Parametric Sources II: NOPA, OPCPA, passive CEP stabilization in OPA**
19	Cancelled 23/12/2016	**Nonlinear Optics with Two-Level Systems** *Problem Set 8 Due, Term Paper Proposal Due*
20		**Carrier-Wave Rabi Flopping**
21	Franz Kärtner 13/01/2017	**Ultrafast Terahertz (THz) Sources** *Problem Set 9 Out*
22		**Applications of Ultrafast Terahertz (THz) Sources**
23	Oliver Mücke 20/01/2017	**High-Harmonic Generation** *Problem Set 9 Due, Problem Set 10 Out*
24		**Attosecond Science**
25	Oliver Mücke 27/01/2017	**Strong-Field Physics in Solids I** *Problem Set 10 Due*
26		**Strong-Field Physics in Solids I**
27	03/02/2017	**Term Paper Presentation** *Term Papers Due*
28		**Term Paper Presentation**