Ultrafast Optical Physics II

SoSe 2017

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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: April 5, 2019

Content:

Linear and nonlinear pulse propagation: Optical solitons and pulse compression.

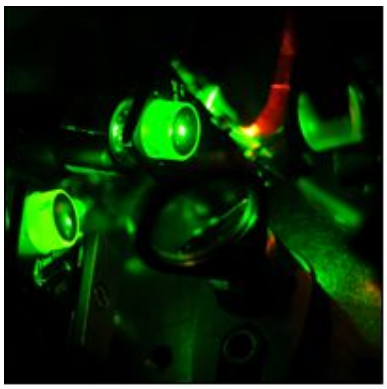
Laser dynamics: Single-mode, multi-mode, Q-switching, mode locking.

Pulse characterization: Autocorrelation, FROG, SPIDER and 2DSI.

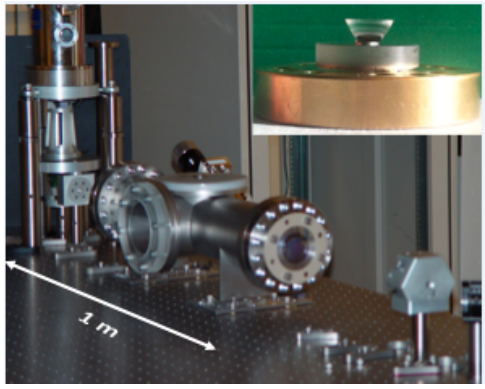
Noise in mode-locked lasers and frequency combs.

Laser amplifiers and parametric amplifiers and oscillators.

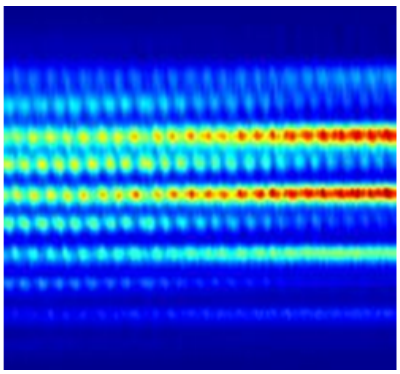
Soft and hard X-ray sources including attosecond pulse generation.



High repetition-rate Kerr-lens Mode-locked Ti:sapphire laser



High energy cryogenically-cooled laser



FROG-CRAB characterization of an attosecond pulse train

Single-cycle pulse synthesizer

Required Textbook:

Class notes will be distributed in class.

Recommended Textbook:

Ultrafast Optics, Andrew M. Weiner, Hoboken, NJ, Wiley (2009).

Additional References:

Waves and Fields in Optoelectronics, H. A. Haus, Prentice Hall, NJ (1984).

Ultrashort laser pulse phenomena: fundamentals, techniques, and applications on a femtosecond time scale, J.-C. Diels and W. Rudolph, Academic Press (2006).

Few-Cycle Laser Pulse Generation and Its Applications, Ed. F. X. Kärtner, Topics in Applied Physics Vo. 95, Springer Verlag (2004).

Principles of Lasers, O. Svelto, Plenum Press, NY (1998).

Optical Resonance and Two-Level Atoms, L. Allen and J. H. Eberly, J. Wiley & Sons NY (1975).

Elements of Quantum Optics, P. Meystre, M. Sargent III, Springer-Verlag, NY, (2007).

Fundamentals of Attosecond Science, Z. Chang, CRC Press, (2011).

Nonlinear Optics, R. Boyd, Elsevier, Academic Press, (2008).

Requirements:

8 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	Kärtner 05/04/2019	**Introduction to Ultrafast Optics**
2		**Optical Pulses and Dispersion**
3	Kärtner 12/04/2019	**Linear Pulse Propagation** *Problem Set 1 Out*
4		**Nonlinear Pulse Propagation**

5	Kärtner 26/04/2019	**Review of Quantum Mechanics** *Problem Set 1 Due, Problem Set 2 Out - Cartella*
6		**Two-Level System and Maxwell-Bloch Equations**
7	Kärtner 03/05/2019	**Laser Rate Equations** *Problem Set 2 Due, Problem Set 3 Out - Cartella*
8		**Laser CW-Operation and Q-Switching**
9	Calegari 10/05/2019	**Nonlinear Schrödinger Equation (NLSE)** *Problem Set 3 Due, Problem Set 4 Out - Cartella*
10		**Pulse Compression and Dispersion Compensation Techniques** *Distribute Term Paper Proposals*
11	Kärtner 17/05/2019	**Master Equation** *Problem Set 4 Due, Problem Set 5 Out - Rossi*
12		**Active Mode-Locking**
13	Kärtner 24/05/2019	**Passive Mode-Locking with Saturable Absorbers** *Problem Set 5 Due, Problem Set 6 Out - Rossi*
14		**Noise in Mode-Locked Lasers**
15	Kärtner 31/05/2019	**Femtosecond Laser Frequency Combs** *Problem Set 6 Due, Problem Set 7 Out - Trabattoni*
16		**Pulse Amplification**
17	Calegari 07/06/2019	**Pulse Characterization I – Autocorrelation** *Problem Set 7 Due, Problem Set 8 Out - Trabattoni*
18		**Pulse Characterization II – FROG**
19	Calegari 21/06/2019	**Second-Order Nonlinear Effects** *Problem Set 8 Due - Trabattoni*
20		**Optical Parametric Amplification**
21	Calegari 28/06/2019	**High Harmonic Generation**
22		**Attosecond Science**
23	Calegari 05/07/2019	**Ultrafast X-Ray Sources**
24		Lab Tour: Ultrafast Optics and X-Rays Group and Attosecond Science Group
25	Kärtner Calegari 13/07/2019	**Term Paper Presentation**
26		**Term Paper Presentation**