

# Ultrafast Optical Physics II

## SoSe 2016

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Lectures (66-370): Fr 08.30-10.00 SemRm 1, Jungiusstrasse 9, start: April 8, 2016  
Recitations (66-371): Fr 10.30-12.00 SemRm 1, Jungiusstrasse 9, start: April 15, 2016

### Content:

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

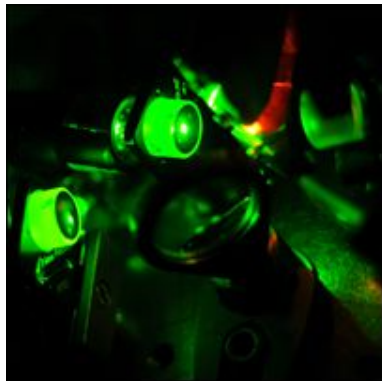
Laser dynamics: Single-mode, multi-mode, Q-switching, mode locking

Pulse characterization: Autocorrelation, FROG, SPIDER and 2DSI

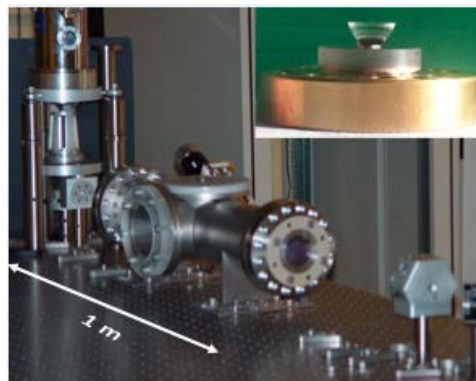
Noise in mode-locked lasers and frequency combs

Laser amplifiers and parametric amplifiers and oscillators

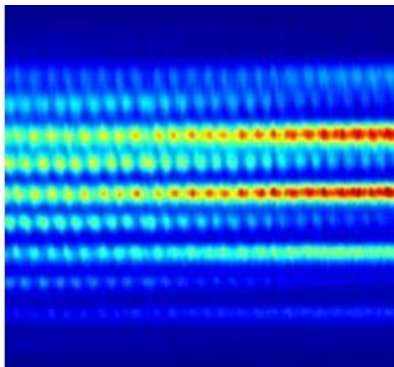
Soft and hard X-ray sources including attosecond pulse generation



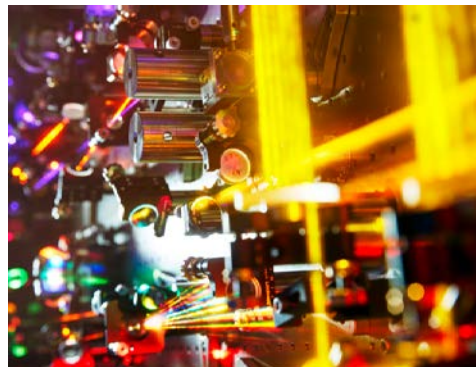
High repetition-rate Kerr-lens  
Mode-locked Ti:sapphire laser



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).

**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 solve 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	Noah Chang 08/04/2016	<b>Introduction to Ultrafast Optics</b>
2		<b>Optical Pulses and Dispersion</b>
3	Franz Kärtner 15/04/2016	<b>Linear Pulse Propagation (I)</b> <i>Problem Set 1 Out</i>
4		<b>Linear Pulse propagation (II)</b>
5	Franz Kärtner 27/04/2016	<b>Nonlinear Schrödinger Equation (NLSE) and Soliton</b> <i>Problem Set 1 Due, Problem Set 2 Out</i>
6		<b>Pulse Compression and Dispersion Compensation Techniques</b>

7	Noah Chang 29/04/2016	<b>Two Level System and Maxwell-Bloch Equations</b> <i>Problem Set 2 Due, Problem Set 3 Out</i>
8		<b>Laser Rate Equations and CW-Operation</b>
9	Noah Chang 06/05/2016	<b>Q-Switching: Active and Passive</b> <i>Problem Set 3 Due, Problem Set 4 Out</i>
10		<b>Master Equation</b>
11	Franz Kärtner 13/05/2016	<b>Active Mode-Locking</b> <i>Problem Set 4 Due, Problem Set 5 Out</i>
12		<b>Passive Mode-Locking with Saturable Absorbers</b> <i>Distribute Term Paper Proposals</i>
	20/05/2016	<b>No Class</b>
13	Franz Kärtner 27/05/2016	<b>Semiconductor Saturable Absorbers</b> <i>Problem Set 5 Due, Problem Set 6 Out</i>
14		<b>Kerr-Lens Mode-Locking</b>
15	Noah Chang 03/06/2016	<b>Pulse Characterization I – Autocorrelation</b> <i>Problem Set 6 Due, Problem Set 7 Out</i>
16		<b>Pulse Characterization II – FROG, SPIDER and 2DSI</b>
	10/06/2016	<b>No Class</b>
17	Franz Kärtner 17/06/2016	<b>Noise in Mode-Locked Lasers</b> <i>Problem Set 7 Due, Problem Set 8 Out</i>
18		<b>Femtosecond Laser Frequency Combs</b>
19	Franz Kärtner 22/06/2016 (Wednesday)	<b>Pulse Amplification</b> <i>Term Paper Proposal Due</i>
20		<b>Second-Order Nonlinear Effects</b>
21	Noah Chang 24/06/2010	<b>Optical Parametric Amplification</b> <i>Problem Set 8 Due</i>
22		<b>Mid-IR and Terahertz (THz) Ultrafast Sources</b>
23	Franz Kärtner 01/07/2016	<b>High Harmonic Generation</b>
24		<b>Ultrafast X-Ray Sources</b>
25	08/07/2016	<b>Ultrafast Optics Group Lab Tour</b>
26		<b>Term Paper Presentation</b>
27	15/07/2016	<b>Term Paper Presentation</b> <i>Term Papers Due</i>
28		<b>Term Paper Presentation</b>

Date: June 2, 2016