

Ultrafast Optical Physics II

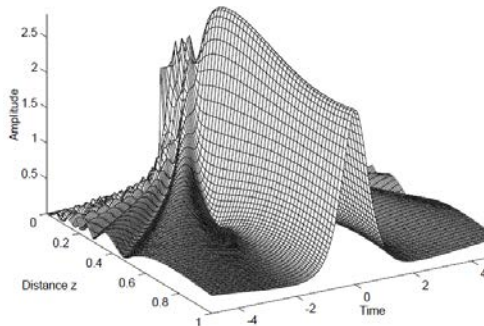
SoSe 2013

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Lectures: Fr 08.30-10.00 SemRm 2
Recitations: Fr 10.30-12.00 SemRm 2
Start: 05.04.2013

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



Soliton-like pulse shaping in mode-locked lasers.



High repetition rate Kerr-Lens Modelocked Ti:sapphire laser



Superfluorescence cone in a parametric amplifier.



Methan-stabilized HeNe-Laser in a molecular optical clock

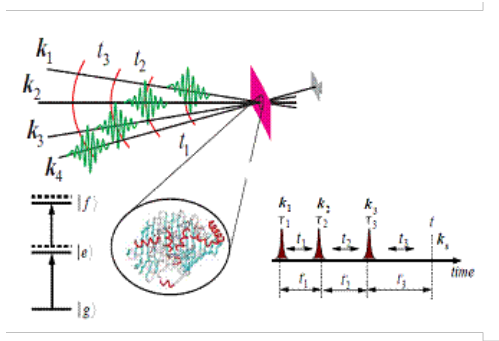
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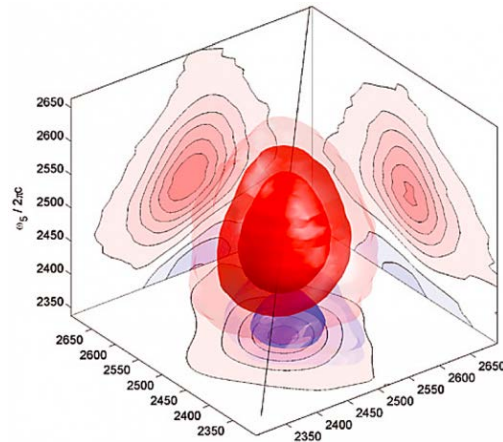
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Content: (cont'd)

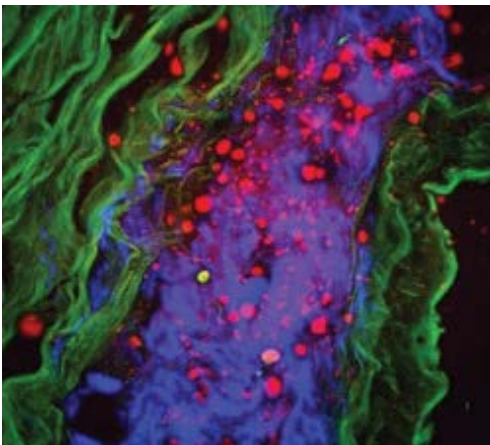
- Nonlinear polarizations in matter: the perturbative expansion approach.
- Ultrafast Fourier-transform spectroscopy: 2 and more dimensions.
- From Ghz to the ultraviolet: investigating transient states of matter with light
- More ways to see: Raman, CARS & fluorescence - also good for imaging
- High-harmonic generation and its applications
- Ultrafast X-ray science: femtosecond molecular movies w/ atomic resolution



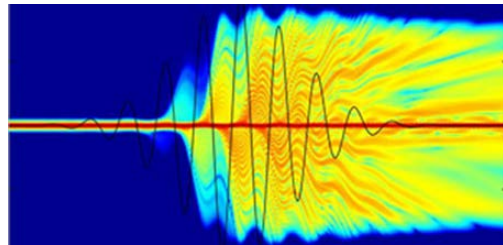
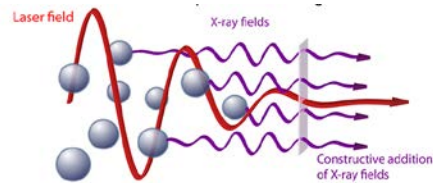
Nonlinear polarizations: separating quantum pathways in space



Femtosecond 3D Fourier-transform spectroscopy at $3\mu\text{m}$ wavelength



SHG-CARS-Fluorescence overlay image using FT spectro-microscopy



High harmonic generation: new sources for ultrafast X-ray science

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Tentative Syllabus:

1	5/4/2013	Introduction to Ultrafast Optics & Linear Pulse Propagation
2		Nonlinear Pulse Propagation <i>Problem Set 1 Out</i>
3	12/4/2013	Laser Dynamics: Single-mode, multimode and Q-switching
4		Active Modelocking <i>Problem Set 1 Due, Problem Set 2 Out</i>
5	19/4/2013	Passive Modelocking
6		Pulse Characterization: Autocorrelation, FROG, SPIDER and 2DSI <i>Problem Set 2 Due, Problem Set 3 Out</i>
7	26/4/2013	Noise in Modelocked Lasers and Frequency Combs
8		Laser Amplifiers <i>Problem Set 3 Due, Problem Set 4 Out</i>
9	3/4/2013	Parametric Amplification
10		Parametric Amplifiers and Oscillators <i>Problem Set 4 Due, Problem Set 5 Out</i>
11	10/5/2013	High Order Harmonic Generation and Attosecond Pulse Generation
12		Free-Electron Lasers <i>Problem Set 5 Due, Problem Set 6 Out</i>
13	17/5/2013	COSY, NOESY, and ROESY: origins of multidimensional spectroscopy
14		The density operator and optical Bloch equations <i>Problem Set 6 Due, Problem Set 7 Out</i>
	24/5/2013	PFINGSTFERIEN
15	31/5/2013	The perturbative expansion of nonlinear polarisations
16		Microscopic theory of dephasing – lineshapes and correlation functions <i>Problem Set 7 Due, Problem Set 8 Out</i>
17	07/06/2013	Nonlinear spectroscopy techniques and...
18		Experimental implementations: Phase-cycling, box-cars and more <i>Problem Set 8 Due, Problem Set 9 Out</i>

19	14/06/2013	Applications: from the THz to the Infrared
20		Applications: visible and UV laser spectroscopy <i>Problem Set 9 Due, Problem Set 10 Out</i>
21	21/06/2013	Stimulated Raman, CARS, and fluorescence upconversion techniques
22		Laser-based short-pulse and FT imaging techniques <i>Problem Set 9 Due, Problem Set 10 Out</i>
23	28/06/2013	High harmonics and attosecond experiments: applications beyond the UV
24		Plasma wakefields & Compton Scattering: more laser-based X-sources <i>Problem Set 10 Due</i>
25	05/07/2013	Applications in ultrafast X-ray science: atoms, molecules, condensed matter
26		X-rays vs. Electrons: ultrafast scattering and diffraction techniques
27	12/07/2013	Lab Tours: Ultrafast Optics Division & Ultrafast Molecular Dynamics Group
28		

Grade breakdown: Übung (30%), Participation (30%), Final (40%)