Syllabus

OSE 6447-0003, Attosecond Optics

Semester: Fall 2015

Zenghu Chang

This course introduces the forefront of attosecond optics research. The materials covered include textbook chapters that explain the fundamental theories and latest journal publications.

1. Prerequisites:

Graduate level wave optics or electrodynamics.
Graduate level quantum mechanics.

For examples:

OSE 6349 Applied Quantum Mechanics for Optics and Engineering or PHY5606 Quantum Mechanics I.
OSE 5041 Introduction to Wave Optics, or OSE 6111 Optical Wave Propagation, or PHY5346 Electrodynamics I,

2. Course assignments/exams:

11 homework assignments. 30 pts from the 10 best homework grades (lowest one is dropped).

3 tests. 30 pts from the 2 best exam grades (lowest one is dropped).

Final exam. Comprehensive. 40 pts

3. Grading procedures:

A: 90-100 pts
B: 80-89 pts
C: 70-79 pts
D: 60-69 pts
F: <60pts (Fail)

4. Textbook:

Zenghu Chang, “Fundamentals of Attosecond Optics,” Taylor and Francis,
ISBN: 9781420089370

5. Course description

This course is offered to introduce the graduate students to the forefront of attosecond optics research. The materials covered include textbook chapters that explain the fundamental theories as well as some latest journal publications. Lab tours will be offered for connecting the theories to the experiments. We will challenge students on the problems that yet to be solved by the scientists in this field.

6. Topics

1 Linear and nonlinear pulse propagation
- 1.1 Description of short pulses in the time and frequency domain
- 1.2 Linear dispersive materials, prism pair and grating pair
- 1.3 Perturbative nonlinear pulse propagation: hollow-core fiber and filamentation
- 1.4 Nonperturbative phenomena: high order harmonic generation and attosecond pulses

2 Attosecond beam propagation
- 2.1 Scattering factor and index of refraction
- 2.2 Photoionization ionization and phase shift
- 2.3 XUV beam focusing and diffraction
- 2.4 Attosecond chirp compensation
- 2.5 Comparison between femtosecond and attosecond pulses

3 High power femtosecond pulse generation and characterization
- 3.1 Mode-locked oscillator and frequency comb
- 3.2 Chirped pulse amplification
- 3.3 Hollow-core fiber compression
- 3.4 Femtosecond FROG and SPIDER
- 3.5 Pulse shaping

4 Carrier-envelope phase stabilization
- 4.1 Carrier-envelope frequency offset and carrier-envelope phase
- 4.2 f-to-2f interferometry and ATI phase meter
- 4.3 CEO and CEP stabilization
- 4.4 VUV frequency comb

5 Attosecond optical pulse generation
- 5.1 Amplitude gating
- 5.2 Two-color gating
- 5.3 Polarization gating
- 5.4 Double optical gating
- 5.5 Phase-matching and quasi-phase matching
- 5.6 KeV sub-attosecond pulse generation

6 Attosecond pulse characterization
- 6.1 Attosecond Streaking
- 6.2 FROG-CRAB
- 6.3 PROOF
- 6.4 Attosecond SPIDER