Concepts of Spectroscopy 1 (iMOS)

Module	Credits	Workload	Term	Frequency	Duration
4 RC	9 CP	270 h	1. Semester	Each WiS	1 Semester
Courses a) Lectures b) Exercises c) Integrated laboratory practical			**Contact hours** a) 2 SWS b) 1 SWS c) 5 SWS	**Self-Study** 120 h	**Group size** a+b) 20 - 50 c) 5-20 Students

Prerequisites

a, b, c) Basic knowledge in quantum chemistry, quantum mechanics, spectroscopic techniques and the necessary mathematical formalism
c) Admission to M.Sc. iMOS

Learning outcomes

After successful completion of the module/course, students will be able to:

- Obtain theoretical and practical knowledge of modern linear and nonlinear spectroscopic methods (time- and frequency-domain) which allow for the elucidation of molecular structure and dynamics in different environments
- Understand applications of laser spectroscopic techniques from the THz to the VUV wavelength region to the study of molecules and their interactions
- Understand practical laser spectroscopic techniques in the lab course and their application in ongoing research projects through a hands-on approach
- Write reports with theories, experiments, and discussion of results

Content

- Electromagnetic radiation, molecular structure, light-matter interaction
- Optical and spectroscopic elements
- Line broadening mechanisms, spectral bandwidth, Fourier transformation
- Molecular symmetry, point groups, molecular symmetry groups
- Rotational spectroscopy: linear, symmetric, spherical, and asymmetric rigid rotor molecules, rotational infrared, millimeter, microwave and Raman spectra
- Vibrational spectroscopy: diatomic and polyatomic molecules, infrared and Raman spectra, vibrational selection rules, normal mode analysis
- Electronic spectroscopy: diatomic and polyatomic molecules, electronic and vibronic selection rules, Franck-Condon transitions, intramolecular nonradiative processes (internal conversion, intersystem crossing), curve crossings and conical intersections
- Laser basics, population inversion and gain mediums, cavity modes, properties of coherent radiation, specific laser systems
- Introduction to nonlinear spectroscopy

Teaching methods

a+b) Active participation during lectures and exercises with problems for self-studying, Q&A and discussion sessions with presentations given by the participants, Moodle course with online material
c) Hands-on laboratory projects to be done in supervised sessions

Mode of assessment

a+b) 2-hour end-of-term written exam on the content of the lectures
c) graded lab reports handed in during the term on the integrated practical

Requirement for the award of credit points

a+b) Passing the written examination and
c) successful acceptance of lab reports

Module applicability a+b+c) M.Sc. iMOS; a+b) M.Sc. Chemistry, M.Sc. Lasers and Photonics
Weight of the mark for the final score Weighted according to CPs iMOS: CP-weighted average of the exam (5 CP) and the lab report (4 CP) grades according to the examination regulations
Module coordinator and lecturer(s) P. Petersen Lecturers from Physical Chemistry departments
Further information