



SCIENTIFIC AND METHOD MODULES

Module name	Basic Concepts in Molecular Spectroscopy
Number	2020-B4
Aims	This module for physicists, chemists and biochemists introduces the basic concepts in molecular spectroscopy, i.e. Infrared (IR), (surface enhanced) Raman- with imaging options and Broadband Dielectric Spectroscopy (BDS), Nuclear Magnetic Resonance Spectroscopy, Optical Microscopy, Superresolution Microscopy, Single Molecule Fluorescence Detection
Basics	The physical foundation of Infra-Red (IR) Spectroscopy and its application to the characterization of gas phase clusters; Broadband Dielectric Spectroscopy (BDS), Raman-, Surface Enhanced Raman-, Nuclear Magnetic Resonance (NMR) and Single Molecule Fluorescence Detection in the solid state, Light Scattering and surface sensitive spectroscopies with imaging options (Nanoscopy) will be presented in detail and some of its modern applications will be discussed. Additionally lab courses will be organized with demonstration experiments.
Contents	The quantum mechanical foundation of Infrared Spectroscopy; experimental principles of Fourier Transform Infrared Spectroscopy; the principle of Broadband Dielectric Spectroscopy and modern applications; basics of pulsed NMR using the classical vector representation, principles of solid-state NMR: anisotropic interactions, dynamic averaging, magic-angle spinning, relaxation; requirements for single molecule fluorescence detection at low and room temperature, optical microscopy schemes as well as microscopic detection beyond the diffraction limit
Methods	Seminars
Type	Two-day block course online
Date (month/year)	21-22 September 2020
Time	See page 2
Work load	15 hours presence/45 hours self-study
Examination	Written examination
Credit points	2
Responsible scientists	F. Kremer, K. Asmis, F. Cichos, K. Saalwächter
Industrial partners	-
Recommendations for literature, e-learning	C. E. Housecroft, E. C. Constable: "Chemistry", Pearson; P. W. Atkins: "Physical Chemistry"; Haken, H.; Wolf, H.C. "Molecular Physics and Elements of Quantum Chemistry: Introduction to Experiments and Theory" (Series: Advanced Texts in Physics) Springer, Berlin, 2004; James Keeler "Understanding NMR spectroscopy", Wiley, Chichester, 2010 and the pdf documents provided at https://cloud.uni-halle.de/s/nH1u62i2xGYzjE6 ; F. Kremer & A. Schönhals: "Broadband Dielectric Spectroscopy" Springer, Berlin, 2003; Bräuchle, Lamb, Michaelis, "Single particle tracking and single molecule energy transfer", Wiley-VCH, Weinheim 2010, Rigler, Orrit, Basché, "Single molecule spectroscopy", Springer, Berlin 2012

SCHEDULE for Module 2020-B4

Time	Lecturer	Program	Location
Monday, 21. September 2020			
8:30-10:00	Frank Cichos	Optical Detection of Single Molecules in Hard and Soft Matter	online
		<i>Coffee break</i>	
10:15-11:45	Frank Cichos	Optical Microscopy and Super-resolution	online
		<i>Lunch break</i>	
13:00-14:30	Friedrich Kremer	Broadband Dielectric Spectroscopy (BDS)	online
		<i>Coffee break</i>	
14:45-16:15	Knut Asmis	Infrared Spectroscopy (IR) of Gas-Phase Clusters	online
16:30-17:30	Knut Asmis and Friedrich Kremer	Optional lab visits and demonstration experiments in the IR and BDS labs (small groups)	Linnéstr. 3/5
Tuesday 22. September 2020			
8:30-10:00	Kay Saalwächter	Basics of NMR	online
		<i>Coffee break</i>	
10:15-11:45	Kay Saalwächter	Solid-state NMR	online

Didactic elements:

All lectures will be presented online; the labtours on Monday afternoon will be organized in small groups. It is expected that every participant is wearing a mask.

Doctoral candidates who have already received two credit points and a mark for the attendance of this module can participate, but cannot receive two graded credit points again or improve their mark.