



SCIENTIFIC AND METHOD MODULES

Module name	Basic Concepts in Molecular Spectroscopy
Number	2021-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 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; modern Applications of Broadband Dielectric Spectroscopy; discussion of the chemical shift Hamiltonian with isotropic and anisotropic parts in NMR spectroscopy, the influence of sample orientation and molecular dynamics on the NMR signals, magic angle spinning, 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, on-site or online according to the COVID-19 regulations at that time
Type	Two-day block course
Date (month/year)	4/5 November 2021
Time	See page 2
Work load	11 hours presence/49 hours self-study
Examination	Written examination
Credit points	2
Responsible scientists	F. Kremer, K. Asmis, F. Cichos, D. Huster
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) (englisch) Springer, Berlin, 2004, K. Schmidt-Rohr & H. W. Spiess: "Multidimensional Solid-State NMR and Polymers" Academic Press, San Diego, 1994, F. Kremer & A. Schönhal: "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 2021-B4

Time	Lecturer	Programme	Location
Thursday, 4th November 2021			
8:30-10:00	Frank Cichos	Optical Detection of Single Molecules in Hard and Soft Matter	
		<i>Coffee break</i>	
10:15-11:45	Frank Cichos	Optical Microscopy and Superresolution	
11:45-12:30	Frank Cichos	Labtour and demonstration experiments	
		<i>Lunch break</i>	
13:30-15:00	Knut Asmis	"Modern Techniques in Infrared Spectroscopy"	
		<i>Coffee break</i>	
15:15-16:45	Friedrich Kremer	Broadband Dielectric Spectroscopy	
16:45-17:30	Knut Asmis and Friedrich Kremer	Labtour and demonstration experiments	
Friday, 5th November 2021			
8:30-10:00	Daniel Huster	Static solid-state NMR line shapes	
		<i>Coffee break</i>	
10:15-11:45	Daniel Huster	Achieving High Resolution in Solids	
11:45-12:30	Daniel Huster	Labtour and demonstration experiments	

Didactic elements:

Lecture, discussions, practical training – lab demonstration, etc.

Expected performance:

Active participation in discussions during lab demonstration etc.

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.