Spectroscopy

Part II: Principles of Magnetic Resonance

Master Chemie, Master Life Science, Master Nanoscience

Summer Semester 2018

Instructor:

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Course info in ILIAS

Information about the course, including course materials, problem sets, and announcements can be found in ILIAS.

Course overview (part II)

The course deals with the physical principles of magnetic resonance spectroscopy, i.e. Nuclear Magnetic Resonance (NMR) and Electron Paramagnetic Resonance (EPR) spectroscopy. After a recap of basic quantum mechanical principles, we will go over both the classical and the quantum-mechanical description of magnetic resonance. We will discuss which physical interactions electron and nuclear spins experience in molecules and how we can measure these using NMR and/or EPR spectroscopy, of course with the goal to obtain molecular structure information on the sample. In the last lecture we will see how dynamic nuclear polarization (DNP) can enhance the sensitivity of MAS NMR.

Learning Objectives

After completion of this course the students will have a deeper understanding of how magnetic resonance spectroscopy works. This will give them flexibility in applying the various forms of magnetic resonance spectroscopy to address chemical and biological questions as well as provide a basis to contribute to the development of magnetic resonance spectroscopy methodology.

Assignments

The problem sets are released one week before each tutorial session. The solutions will be discussed in the working classes.

Final grade

The final grade for the course will be based on a 30-min oral exam.

Study Material

The course will cover selected topics from:
- Introduction to Quantum Mechanics - David. J. Griffiths
- Understanding NMR Spectroscopy – James Keeler
- Spin Dynamics – Malcolm Levitt
- Principles of Pulse Electron Paramagnetic Resonance - Arthur Schweiger and Gunnar Jeschke

The student may also want to consult:
- Modern Quantum Mechanics - J. J. Sakurai
- Principles of Magnetic Resonance - Charles P. Schlichter
- Principles of Nuclear Magnetic Resonance in One and Two Dimensions – Richard R. Ernst, Geoffrey Bodenhausen, and Alexander Wokaun

Miscellaneous study material will be posted in ILIAS.

Credits

The credit for the course is 6 ECTS. The course can be extended with an additional 6 ECTS by doing a research internship (4-5 weeks) in one of the (bio)physical chemistry groups: Drescher, Hauser, Mathies, Zumbusch.

Schedule

	Topic	Date, Time	Room
Lecture 1a	Quantum Mechanical Basics, Orbital and Spin Angular Momentum	Tue. Jun. 5, 11:45-13:15	ML630
Lecture 1b		Wed. Jun. 6, 10:00-11:30	H307
Tutorial 1		Tue. Jun. 12, 11:45-13:15	ML630
Lecture 2	Vector model, Bloch Equations, Rotating frame	Wed. Jun. 13, 10:00-11:30	P602
cancelled		Tue. Jun. 19, 11:45-13:15	ML630
Lecture 3	Observing magnetic resonance, Ensembles of spins, Density matrix	Wed. Jun. 20, 10:00-11:30	P602
Tutorial 2		Tue. Jun. 26, 11:45-13:15	ML630
Lecture 4	Terms of the spin Hamiltonian, Anisotropy	Wed. Jun. 27, 10:00-11:30	P602
Tutorial 3		Tue. Jul. 3, 11:45-13:15	ML630
Lecture 5	Product operator formalism, The spin echo, INEPT	Wed. Jul. 4, 10:00-11:30	P602
Tutorial 4		Tue. Jul. 10, 11:45-13:15	ML630
Lecture 6	Dynamic Nuclear Polarization (DNP)	Wed. Jul. 11, 10:00-11:30	P602
Tutorial 5		Tue. Jul. 17, 11:45-13:15	ML630