Hoorcollege

Introduction into Spectroscopy

Autumn semester 2009

Programme:

1. Principles of spectroscopy
2. Transitions between electronic states
3. Rotational & vibrational spectroscopy
4. Electron resonance methods
5. Nuclear magnetic resonance methods

Lecturer: Dr. Jörg Matysik
Language: English
Literature: Syllabus
Doelgroep: 3rd year BSc MST

Further information:
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LCP 101, tel. 4198.

The programme

1 Principles of spectroscopy

1.1 Properties of electromagnetic radiation

Frequency ranges, polarization

1.2 Coupling of electromagnetic radiation to matter

Absorption, electric dipole transitions, Lambert-Beer law, Kirchhoff's law, Stefan-Boltzmann's law, Wien's displacement law, Rayleigh-Jeans law, Planck law, absorption and emission, Einstein coefficients, scattering, Rayleigh and Mie scattering, refraction, Snell's law, refraction & reflectance, reflection.

1.3 Spectrometers

Absorption and emission spectrometers.

1.4 Linewidth

HWHH, Lorentz, Gauss and Voigt.

2 Transitions between electronic states

2.1 Electronic transitions of atoms

Fraunhofer lines, spectral analysis, selection rules, orbital and spin moments, spectrum of hydrogen, term symbols, spin-orbit coupling, Zeeman effect, Stark effect

2.2 Electronic transitions of molecules

Diatomic molecules, heteronuclear diatomic molecules, selection rules, particle in the box model, types of electronic transitions, vibrational fine structure, Franck-Condon factors, circular dichroism

2.3 Photophysics

Electronic absorption, fluorescence, phosphorescence, absorption into the continuum, epifuorescence microscopy, principle of a laser

3 Rotational & vibrational spectroscopy

3.1 Molecular energy distribution

Boltzmann distribution, density of states

3.2 Pure rotational spectra

Moment of inertia, selection rules, rotational spectra, rotational Raman effect

3.3 Vibrational spectra

Force constant, energy potential, selection rules, band shapes, frequencies, polyatomic molecules, normal modes, vibrational Raman, Resonance Raman

3.4 Spectrometers

IR, Raman, dispersive and FT, CARS

3.5 Signal intensities

Selection rules, character tables, symmetry

4 Electron resonance methods

4.2 Magnetic transitions of electrons

Spin, magnetization, magnetic transitions, Zeeman effect in optical spectroscopy and magnetic resonance.

4.3 EPR as method

History, mw region, saturation method, stimulated emission.

4.4 A pulsed EPR experiment

Classical description, resonance, q-m description, pulse sequence, phase sensitivity, definitions (Polarization, magnetization, relaxation), EPR spectrometer.

4.5 The EPR spectrum

Hf-interaction, dipole-dipole interaction, exchange interaction, fine splitting (zero-field splitting), g-value, hf-structure, McConnell equation, electron-nuclear interactions, spin-spin-couplings.

4.6 Special EPR methods

Spin probes, T_1 experiments, ENDOR.

5 Nuclear magnetic resonance methods

5.1 History and principle

History, nuclear spins, nuclear transitions, NMR spectrum, chemical shifts, J couplings, dynamic processes.

5.2 Pulse NMR

Pulses, FID, relaxation, correlation time, linewidth, T_1 determination, echo experiments, T_2 determination.

5.3 NMR Techniques

Gradients, MRI, spin decoupling, nuclear Overhauser effect, 2-dimensional spectroscopy, magic-angle spinning NMR.

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