Applications of Continuous Wave and Pulsed UNIVERSITÄT DES **Electron Paramagnetic Resonance Spectroscopy** SAARLANDES

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Introduction: What is EPR spectroscopy?

spectroscopy is a powerful technique, giving insights into the structure of EPR materials/molecules and proteins. Paramagnetic substances like e.g., unpaired electron spins of radicals, are exposed to a magnetic field to tune the zeeman splitting between the two possible spin states. Subsequently, the resulting energy transitions get probed by microwave (MW) irradiation. Generally, a distinction between two modes of operation is made: Continuous wave (CW) and pulsed MW irradiation.

Both methods incooperate distinct spectral features which can give answers to different structural investigation issues. Our work is widely collaborative and brings together biologists,





Alternative CW and pulsed EPR methods and their spectral features



CW operation

- Hyperfine coupling between nuclei and electron (A)
- Nuclei type (nuclear isotope spin)
- g-value/-anisotropy (powder)
- Dynamics (rotational correlation time RCT)

Pulsed operation

- T_1 spin lattice relaxation time (Three pulse inversion recovery)
- T_2/T_m spin-spin coherence time (delayed Hahn-Echo)
- T_2^* phase memory time
- Rabi/nutation experiments (One Pulse experiment)







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- Transient EPR (photoexcited triplet states)
- Time-dependence and low lifetime intermediates (spin traps)
- Variable temperatures
- Power saturation $(O_2/N_2$ accessability of membrane proteins)

Advanced pulse EPR methods

- Electron nuclear double resonance (ENDOR)
- Electron spin echo envelope modulation (ESEEM)
- Hyperfine sublevel correlation (HYSCORE)
- Pulsed electron double resonance (PELDOR/DEER)

Conclusion – Takehome messages

- > EPR excels as a valuable tool in combinations with other spectroscopy methods for structural investigations
- > Provides insight into dynamic processes where electrons are involved which cannot be investigated by other methods (NMR, UV-Vis, IR, ...)
- Exceptional high sensitivity requires only small sample volume and concentrations in sample preparation
- > Interdisciplinary research methodolgy

References

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