

NMR spectroscopy with *in situ* irradiation as a powerful tool to study photochemical processes

Light-sensitive small organic molecules are in the focus of interest not only in physical organic chemistry and material science, but also in molecular biology. Photochromic compounds reversibly change their structure and properties upon irradiation, which makes them ideal candidates for incorporation into photo-responsive “smart” materials, widely used in optoelectronics, catalysis or optogenetics. Photosensitive moieties can also work as a cap for photo-triggering of more complexed processes (*e.g.* catalysis, complexation, self-immolation etc.).

Photochemical processes can be investigated by conventional NMR spectroscopy (with *ex situ* irradiation) only if the half-life time is long enough or the species can be isolated. But the investigation of compounds that not fulfill these criteria is challenging. For these purposes, a special illumination device, where the light is guided directly into the NMR spectrometer by an optical fiber, has been introduced and recently implemented at IOCB. This setup enables monitoring of structural changes upon irradiation in real time, observation of saturation and stationary states of photochromic systems, structure determination of metastable species and access to kinetic data by subsequent analysis.

The Ph.D. student should work on the following sub-topics:

1. Structure determination of organic compounds newly prepared by organic chemists at IOCB by NMR spectroscopy. Structure determination of different classes of compounds will give an overview in small-molecule NMR techniques.
2. Structure, reactivity and self-immolation (SI) in photo-triggered phosphate-based molecules. Self-immolative linkers are important constructs in drug delivery systems (*e.g.* ProTide prodrugs) and the detailed mechanistic study is crucial for rational design of new systems with desired properties, such as a speed of drug release, multi-cargo delivery, targeting into specific cells or tissues etc.
3. Conformation and configuration of SI linkers. The phosphate-based SI constructs are usually prepared as a mixture of two diastereoisomers due to two chiral centers in the molecule. However, biological activity of the diastereoisomers can be significantly different.
4. Structure and properties of azopyrimidines, a new class of photoswitches are currently being developed at IOCB. Azopyrimidines can isomerize into *cis* isomer upon UV/Vis irradiation similarly as azobenzenes, but incorporation of a heterocyclic ring can bring many advantages, *e.g.* higher chemical and thermal robustness or conformational stability. Azopyrimidines can act as base/acid, have chelating properties or form complexes.