Advanced Module Description: THz-FTIR Spectroscopy

Background and application: The key mechanisms of the water network dynamics are the breaking and formation of hydrogen bonds, the stretching vibration of the O-H···O bond and the rotational relaxation of the water molecules, all occurring on a picosecond time scale. Since one picosecond (10^{-12} s) corresponds to a frequency of one Terahertz (10^{12} Hz), a suitable method to investigate the dynamics of the water network is THz (FTIR) absorption spectroscopy. With THz absorption measurements, the intermolecular hydrogen-bond dynamics are probed. Therefore, the absorption band of water is very sensitive to changes in the molecular network. The investigation of the THz absorption of aqueous solutions has proven a vital tool to obtain insights into the dynamical hydration of salts, organic molecules, proteins, or other solutes. Solvation of a salt in water generally gives rise to bands in the absorption spectrum, which can be attributed to rattling motions of the ions in the surrounding water network. Investigation of these bands can provide important information about the local environment around the ions and the mechanisms of their hydration.

Module Tasks: This advanced module will give a hands-on introduction to THz-FTIR spectroscopy. In this module participants will take part in the preparation of a helium cooled detector and standard FTIR instrument. An introduction to the handling of solutions for optical spectroscopy, and respective liquid sample cells will also be given. Practically, participants will measure the THz spectra of aqueous salt solutions under supervision and the acquired spectra will be analysed using common scientific software (e.g. Mathematica, Matlab) in order to dissect the spectra into cationic and anionic contributions.