Physical Methods in Inorganic Chemistry

Steady-state and time-resolved (pump-probe) spectroscopy – Jaco J. Geuchies (UL)

Light-matter interactions can teach us a lot about the properties of materials. Probing the response as light is transmitted, reflected or scattered by materials as a function of the lights' frequency will can give us information on chemical composition, (nano)particle size, bond strengths and much more.
Here we will briefly go over the basics of steady-state spectroscopy, including the Lambert-Beer-Bouguer law, selections rules for (electric dipole) transitions and scattering (Raman processes) and important differences between transmission, reflection, absorption and extinction that often lead to confusion in literature and amongst peers (not alone because of misused nomenclature).

After this, we will extend these methods to the "ultrafast" time-domain by exciting the system to be studied with a short laser pulse, the pump, after which the response of the system is measured using a probe. Depending on the frequencies used for both the pump and the probe, one can study different time-dependent phenomena, such as electron relaxation, recombination, electron transfer, electron localization and release, electron transport and mobility, vibrational orientation and transport, and many more. I will present the basics behind the techniques from both a theoretical and practical point of view, after which we will go through examples highlighting the strengths and weaknesses of each of these methods.

The goal is to present a comprehensive overview of the possibilities of (time-resolved) spectroscopy from both a theoretical and practical point of a view, giving the audience a toolbox from which they can pick the right hammer (spectrometer) to hit their desired nail (scientific problem) directly on the head.