Laser control of excited-state vibronic dynamics in small molecules

Master/Bachelor Thesis project at MPIK Heidelberg

Contacts:
Gergana Borisova (borisova@mpi-hd.mpg.de),
Christian Ott (christian.ott@mpi-hd.mpg.de),
Thomas Pfeifer (thomas.pfeifer@mpi-hd.mpg.de)

Attosecond transient absorption spectroscopy (ATAS) is a spectroscopic technique making use of the shortest attosecond-long light pulses to access quantum dynamics on the natural time-scale of the electron movement in atoms and molecules. In a combination with a second laser pulse, typically a near-infrared pulse of high intensity, pump-probe type experiments bring information about electron movement in atoms as well as nuclear movement in molecules. Making use of a very good spectral resolution, in our experiment we can record ATAS spectra from both atoms and molecules in the extreme ultraviolet (XUV) spectral region. From the measured absorption spectra we reconstruct the dynamics in the measured system. In this project we will focus on nuclear dynamics in small molecules like H_2, D_2, HD, O_2, N_2, studying wave-packet dynamics with the aim to control the wave-packet movement and steer it in a desired direction by the applied NIR field, with adjustable intensity and polarization. You will learn to work with the shortest laser pulses on the attosecond and femtosecond time scales and use those to change molecular dynamics. The development of numerical few-level models will help for further understanding of the studied dynamics.

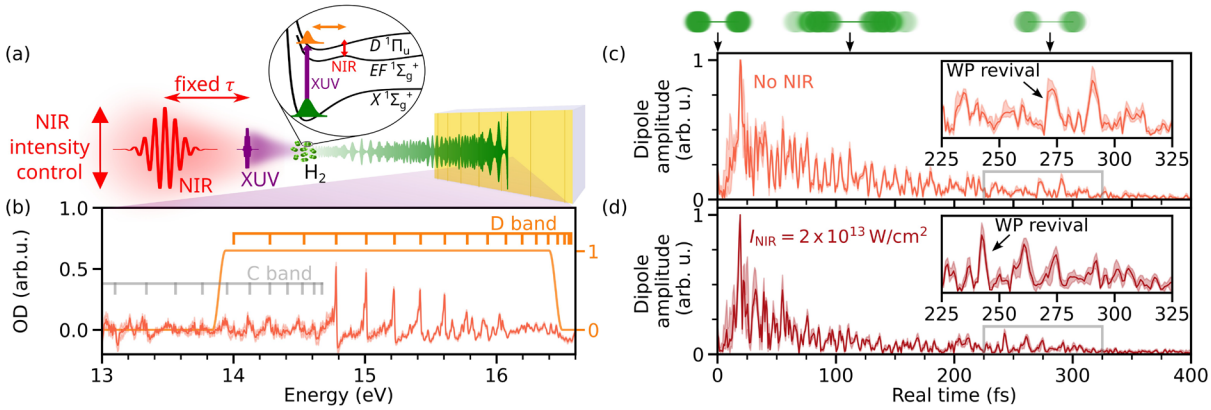

Figure: (a) Schematic of the experimental setup for XUV time-domain absorption spectroscopy in H_2. (b) Optical density (OD) spectrum showing the detected vibronic resonances in H_2. (c) and (d) Reconstructed time-dependent dipole amplitude of the *D*-state vibrational wave packet in an XUV-only configuration and for an NIR control field with $I_{NIR} \approx 2\times10^{13}$W/cm^2, respectively. The insets show the wave-packet revival region and the green illustrations represent the vibrating molecule at different times.