Vibrational control of d-d electronic transitions in $CuGeO_3$

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The interplay between phonon excitation and electronic transitions is at the core of the exotic properties of complex material. Recent development of mid-infrared impulsive sources have enabled the study of ultrafast responses of different electronic degrees of freedom following the resonant excitation of vibrational modes [1,2]. In particular, pioneering experiments have shown that the resonant excitation of low energy vibrational states by THz pulses can trigger the onset of surprising transient states of matter such as superconductivity.

Following the scheme of resonant excitation of low energy modes and spectroscopic probe of the visible transient response, we have developed a setup coupling tunable mid-IR pump pulses (from 4 to 17.5 µm) and tunable visible probe pulses (from 600 to 900 nm) in order to study electron-phonon coupling in copper germanate (CuGeO3). Thus, by exciting vibrational modes along the b or c axis of CuGeO3 with mid-IR pulses, we are able to control specific lattice distortion and measure their influence on copper d-d onsite transition. By monitoring the transient transmittivity and birefringence of the probe we have revealed an ultrafast change of the optical properties resonant to the d-d absorption band demonstrating, on a model crystal, that vibrational excitation can be used to control the local crystal field in transition metal oxides.

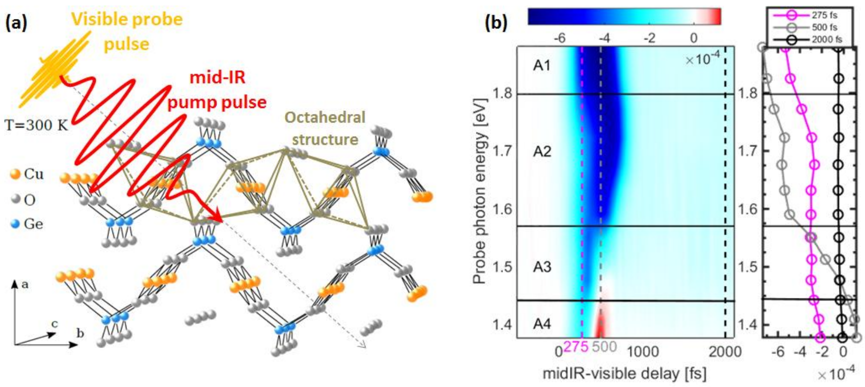

Figure. a) Scheme of principle of the study performed on $CuGeO_3$. b) Transient transmittivity map for different probe photon energy. The particular dynamical response shows how the crystal field is modified by an excitation of weak energy modes.

References

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