

# Ultrafast imaging of the Renner-Teller effect in a field-dressed molecule

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**Synopsis** We present experimental results of linear-to-bent transition of field-dressed molecules, mediated by Renner-Teller effect. Using the state-of-the-art laser-induced electron diffraction (LIED) technique, we image a bent and symmetrically stretched carbon disulfide (CS<sub>2</sub>) molecule populating an excited electronic state under the influence of strong laser field. Our findings are well-supported by *ab initio* quantum mechanical calculations.

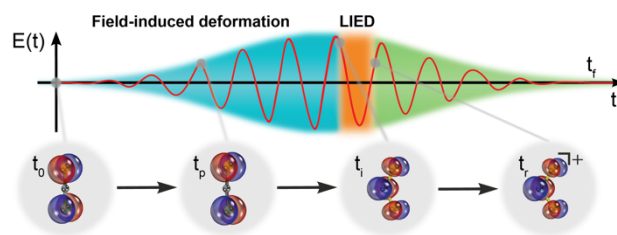
High-resolution ultrafast dynamics of structural changes are essential in the real-time observation of chemical reactions. Here, we observe ultrafast structural changes in CS<sub>2</sub> with a single-pulse excitation and imaging under the influence of strong laser field [1].

The experiment was performed using the LIED technique [2, 3] with the help of a passively CEP-stable mid-IR OPCPA laser system (3.2 μm, 110 fs, 160 kHz) [4] coupled with a reaction microscope [5], the latter of which is capable of measuring the full three-dimensional momenta of all charged particle species.

LIED probes an object's structure using its own electrons that are elastically re-scattered during strong-field induced re-collisions, as explained by the semi-classical re-collision model [6]. The excursion time of the rescattering electron and its high momentum transfer ( $\sim 9.5 \text{ \AA}^{-1}$ ) provide a sub-femtosecond temporal resolution and picometre spatial resolution, respectively.

Our experimental findings show that the vibronic excitation of neutral CS<sub>2</sub> to a bent and symmetrically stretched structure occurs during the rising edge of our LIED laser field, as illustrated in Fig. 1. Our *ab initio* quantum dynamical calculations show that the measured bent structure in CS<sub>2</sub> in the presence of strong field is due to a linear-to-bent structural change mediated by the Renner-Teller effect, and is a conse-

quence of the coupling of rovibronic states to the electronic states.



**Figure 1.** The CS<sub>2</sub> molecule is initially stretched and bent by 10° (at  $t_p$ ) before leading to a bent CS<sub>2</sub> structure that is ionized (at  $t_i$ ) and imaged by high-energy rescattering electrons (at  $t_r$ ).

In future work, LIED can be extended to two-pulse pump-probe studies to investigate the pathways of structural photo-induced chemical reactions such as those in the photoisomerization of photoswitching molecules.

## References

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