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The ultrafast soft x-ray and electron diffraction perspective on photophysics in the gas phase

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The conversion of light energy into other energy forms in molecules is the result of a concerted and ultrafast motion of electrons and nuclei, often under breakdown of the Born-Oppenheimer approximation. This talk is about ultrafast experiments aimed at resolving light induced ultrafast molecular dynamics with x-ray probe pulses using free electron lasers as well as relativistic electron pulses.

We present experiments on internal conversion of the nucleobase thymine, which we probe by femtosecond resonant x-ray spectroscopy at the oxygen K-edge. We deduce a less than 100 fs $\pi\pi \rightarrow n\pi$ transition, which plays a crucial role in the photoprotection of this nucleobase [1].

In addition, we present results from femtosecond electron diffraction experiments on electronically excited states of small molecules, that unravel wavepacket dynamics with Angstrom level spatial resolution and femtosecond domain temporal resolution [2,3].

[1] Probing ultrafast $\pi\pi/n\pi$ internal conversion in organic chromophores via K-edge resonant absorption, T. J. A. Wolf, R. H. Myhre, J. P. Cryan, S. Coriani, R. J. Squibb, A. Battistoni, N. Berrah, C. Bostedt, P. Bucksbaum, G. Coslovich, R. Feifel, K. J. Gaffney, J. Grilj, T. J. Martinez, S. Miyabe, S. P. Moeller, M. Mucke, A. Natan, R. Obaid, T. Osipov, O. Plekan, S. Wang, H. Koch and M. Gühr, Nature Communications 8, 29 (2017)

[2] Diffractive Imaging of Coherent Nuclear Motion in Isolated Molecules

J. Yang, M. Guehr, X. Shen, R. Li, T. Vecchione, R. Coffee, J. Corbett, A. Fry, N. Hartmann, C. Hast, K. Hegazy, K. Jobe, I. Makasyuk, J. Robinson, M. S. Robinson, S. Vetter, S. Weathersby, C. Yoneda, X. Wang, M. Centurion, Phys. Rev. Lett. 115, 173002 (2016)

[3] Imaging CF₃I conical intersection and photodissociation dynamics with ultrafast electron diffraction, J. Yang, X. Zhu, T.J.A. Wolf, Z. Li, J.P.F. Nunes, R. Coffee, J.P. Cryan, M. Gühr, K. Hegazy, T.F. Heinz, K. Jobe, R. Li, X. Shen, T. Vecchione, S. Weathersby, K.J. Wilkin, C. Yoneda, Q. Zheng, T.J. Martinez, M. Centurion, X. Wang, Science 361, 64 (2018)

Summary

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