Time-resolved Coulomb explosion imaging of CO ultrafast dynamics using few-cycle IR and EUV laser pulses

A. S. Alnaser*[1], I. Bocharova[2], K. Singh[2], C. Wei[2], M. Kling[3], C. L. Cocke[2], I. V. Litvinyuk[2]

[1] Department of Physics, American University in Sharjah, Sharjah, United Arab Emirates
[2] J. R. Macdonald Laboratory, Physics Department, Kansas State University, USA
[3]Max-Planck Institute for Quantum Optics, Garching, Germany

Synopsis: We have used few-cycle IR and EUV laser pulses in pump-probe arrangement to trace out the dissociation pathways in CO when exploded by strong laser fields. We present two preliminary sets of data of different pump pulses. In these sets, different excited state of CO cations are populated using (< 10 fs) IR, and EUV pulses respectively. We followed the time evolution of these states using the time-resolved Coulomb explosion imaging technique. We compare the time evolution of IR- and EUV-induced excited states by measuring the KER of the fragment ions as a function of the time delay between the pump and the IR probe pulse.

The availability of extremely short intense laser pulses makes it now possible to follow in real time the heavy particle dynamics of light molecules and to determine their different dissociation pathways [1]. A non-stationary wave packet can be launched onto a potential curve of the molecule through ionization of the neutral, and the subsequent motion of this time-dependent wave packet can be followed as it coherently couples to other potential curves in the ionized system.

In this work, we have used intense laser pulses in a pump-probe arrangement to trace out the rapid evolution of wave packets launched onto different states of CO cations. We utilized 8 fs IR and 10 fs EUV laser pulses as ionizing pulses that set CO in different excited ionic states. After a time delay ranging from 0 to 200 fs, a second IR pulse, of controllable intensity removes one or more electrons, causing the system to "Coulomb explode" into different pairs of charged fragments. These fragments were detected in coincidence, and their full momenta were measured, using the well established COLTRIMS techniques. We measured the KER as well as the angular distribution of the resulting fragments as a function of the delay between the pump (whether it is an IR or EUV) and the IR probe pulses.

Figure 1 shows the momentum image generated when CO is dissociated to C^+ and O^+ fragments by Ar EUV attosecond train. As shown in the figure the two fragments exhibit different angular dependence with respect to the radiation polarization; a signature of the excited state that is populated. In addition, we will present time-dependent KER spectrum obtained with EUV (or IR) as a pump and IR as a probe.

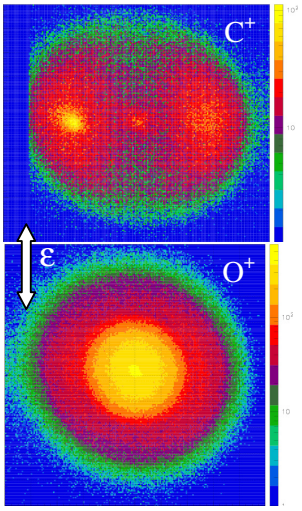

Fig. 1. Momentum image of the C^+ (up) and O^+ ions generated from the dissociation of CO by few-cycle EUV laser pulses. The polarization is vertical.

This work was supported by Chemical Sciences, Geosciences and Biosciences Division, Office of Basic Energy Sciences, Office of Science, U.S. Department of Energy. ASA acknowledges FRG support from American University of Sharjah.

References

1. Alnaser A S *et al*., Phys. Rev. A 72, 030702, (2005).

* aalnaser@aus.edu