CFEL SCIENCE

SEMINAR

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CFEL – Building 99, seminar room I+II (ground floor)

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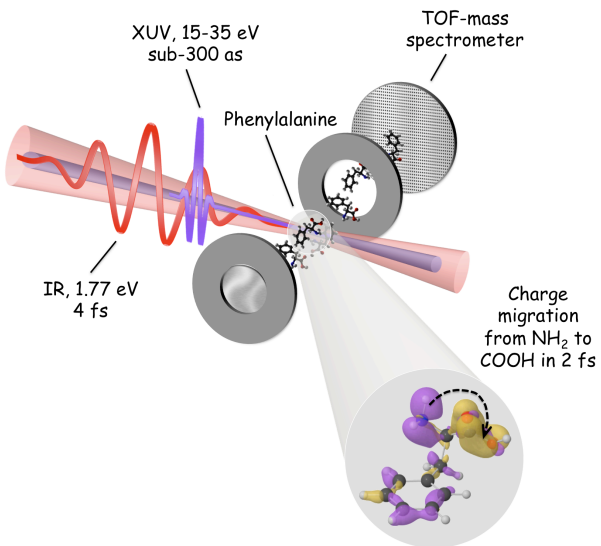
Observation of pure electron dynamics in biomolecules induced by attosecond pulses

Dynamical processes in molecules occur on an ultrafast temporal scale, ranging from picoseconds (1ps=10^{-12} s) to femtoseconds (1fs =10^{-15} s) when concerning with a structural change, down to attoseconds (1as = 10^{-18} s) when dealing with electrons. Electron dynamics plays a very important role in bond-formation and bond-breakage, thus determining the final chemical reactivity of the molecule. Recently, theoretical studies have pointed out that after sudden ionization of a large molecule very efficient "charge migration", driven by purely electronic effects, can occur along the molecular backbone on a temporal scale ranging from few femtoseconds down to tens of attoseconds [1].

In this talk I will report on a clear experimental measurement of charge migration in the amino acid phenylalanine, after attosecond excitation. In our experiments, charge migration was measured by using a two-color, pump-probe technique [2]. Charge dynamics was initiated by isolated sub-300-as pulses, with photon energies in the spectral range between 15 eV and 35 eV and subsequently probed by 4-fs, waveform-controlled visible/near infrared (VIS/NIR) pulses, with central wavelength of 750 nm. A clean plume of neutral molecules of phenylalanine was generated by evaporation from a thin metallic foil heated by a CW diode laser. The ions produced by the interaction of the molecules with pump and probe pulses were then collected by a linear time-of-flight device for mass analysis.

We have measured the evolution of the yield of the doubly charged immonium ion (m/q = 60) as a function of the delay between the attosecond pump pulse and the NIR probe pulse. The dication yield displays a clear oscillatory dynamics with a frequency of 234 THz (corresponding to a period of 4.3 fs). This ultrafast dynamics can only be associated with purely electronic processes, thus constituting the first experimental measurement of charge migration in a biomolecule [3]. Numerical calculations predict charge dynamics characterized by oscillation frequencies in good agreement with the experimental results.



[1] L. S. Cederbaum et al Chem. Phys. Lett. 307, 205 (1999)
[2] L. Belshaw et al J. Phys. Chem. Lett. 3 375 (2012)
[3] F. Calegari et al Science, accepted

Host: Terry Mullins / CFEL Molecular Physics Seminar