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Ultrafast Charge Migration in Biological Building Blocks

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When a complex molecule or molecular complex is suddenly disturbed from equilibrium, when for instance a photon is absorbed or an electron is ionized by energetic radiation, it is left in a superposition of electronically excited states. The evolution of this electronic wavepacket then results in charge separation/transfer which can be the initiator for subsequent chemical processes. The initial motion of the charge is expected to occur on attosecond to few femtosecond timescales before coupling with the nuclear motion modifies the wavepacket eventually resulting in the formation of a stationary state and localisation of the charge.

To observe this intramolecular, coherent electron dynamics, known as charge migration, in a nanoscale structure is very challenging given the complexity of the problem and the timescales involved. With the advent of attosecond laser technology in the last 10 years it is now possible to generate pulses which are short enough to resolve these processes in the time domain. In this talk I will describe work which we have undertaken at the Politecnico Milano Attosecond Laser Facility, which has for the first time allowed us to observe ultrafast charge oscillations in a large molecule – in this case the amino acid phenylalanine[1,2].

[1] Observation of Ultrafast Charge Migration in an Amino Acid,
L. Belshaw et al., J. Chem. Phys. Lett., 3, 3751−3754 (2012)

[2] Ultrafast Electron Dynamics in Phenylalanine Initiated by Attosecond Pulses
F. Calegari et al., Science, 346, 336-339 (2014)