Attochemistry: imaging and controlling electronic motion in molecules with attosecond time resolution

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The attosecond is the natural time scale of electronic motion in matter. Therefore, this time scale is key in chemistry. From water to DNA, all chemical reactions involve breaking and forming bonds, in which atomic nuclei are forced to live close to each other or to separate forever. But this is the consequence of the way electrons move. Thus, chemical reactivity results from the combined action of the "fast" electronic motion and the "slow" motion of atomic nuclei. Following the motion of the latter was possible by the end of the twentieth century with the help of femtosecond laser pulses. With the advent of attosecond light pulses at the dawn of the twenty first century, access to the ultimate time scale responsible for chemical transformations was finally at our reach. This was accomplished in 2010 [1] for the simplest molecule in nature, hydrogen, and, in 2014 [2], for phenylalanine amino acid. Since then, the field has grown exponentially, leading to a discipline called attochemistry [3]. In this talk, I will review some of the most relevant experimental and theoretical achievements in attosecond science, in particular attochemistry, and recent efforts that go beyond traditional pump-probe approaches. All these guided by theoretical modelling [4], which has been an essential ingredient since the very beginning of this discipline. Attochemistry is still at its infancy, but its long-term goal, achieving control of chemical processes by acting on electronic motion at its natural time scale does not seem to be a remote possibility anymore.

References

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