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Imaging ultrafast molecular dynamics using attosecond pulses: from hydrogen to amino acids

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One of the most successful experimental approaches uses an ultrashort pulse in the VUV/XUV region to trigger molecular excitation or ionization, whose dynamics is then probed by the time-delayed interaction with an IR field or, ideally, with a second VUV/XUV pulse. This talk will shortly review the state-of- the- art theoretical methods that have been able to give a reliable description of ultrafast electron dynamics with sub-femtosecond resolution in recent applications using targets ranging from the hydrogen molecule to amino acids. The relevance of electron-electron and electron-nuclei correlation is explored in different scenarios. Firstly, specific applications of standard XUV/IR pump-probe protocols are explored, where the XUV ionizes the molecule into a coherent superposition of excited states of the ion and the IR field then traces the dynamics into the doubly ionized species. The evolution of the ultrafast electron dynamics is examined in two distinct scenarios: i) the dynamics triggered by single or trains of attosecond pulses in hydrogenic molecules, where the time scales of electronic and nuclear motion are comparable and ii) the dynamics launched by an attosecond pulse in amino acids, where charge migration is observed prior nuclear rearrangement. Secondly, novel approaches using single chirped VUV/XUV pulses to retrieve electron-nuclear dynamics with sub-femtosecond resolution in small target molecules are explored. The talk will conclude with a short view of the current challenges for nearly-exact theoretical simulations to describe laser-induced ultrafast processes.