Control of Electron Dynamics in Light Systems Using Attosecond XUV and Femtosecond IR Radiation

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Inducing a chemical process and controlling its outcome in real time is a central theme of attosecond science. Understanding the interaction of attosecond pulses with an atomic system fully accessible to the best available theoretical calculations is essential for the progress of this science. In this work we characterize some underlying processes behind the infrared-assisted ionization of helium by XUV radiation. We show that, if used in the form of an attosecond pulse train (APT) which has good resolution in both energy and time, processes are seen which could not be observed without high resolution in both domains simultaneously. We show that resonant absorption is important in the excitation of the helium and that small changes in the energies of the harmonics which comprise the APT can result in large changes in the ionization process. Good agreement between the data and theoretical calculations is found. With the help of this agreement, ionization pathways for the infrared-assisted ionization of helium by XUV attosecond pulses have been identified and simple model interpretations have been developed which should be of general applicability to more complex systems.