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Probing and Controlling Electronic Dynamics on the Attosecond Scale[1]

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With the advent of sub-femtosecond ultrashort XUV pulses and of phase-stabilized few-cycle IR pulses with sub-cycle time resolution, novel pathways have opened up for studying time-resolved electronic processes on the attosecond scale. These experimental advances pose challenges for theory: How do short pulses interact with matter? Which novel information can be extracted from such time-resolved spectroscopies that is difficult or even impossible to access in the spectral domain? In this talk, these issues will be addressed with the help of a few examples. Attosecond streaking allows a direct look at electronic correlations and rearrangement processes including the formation of shake-up states during photoionization. Photoemission from a tungsten surface reveals an attosecond time delay between conduction and core electrons and provides time-resolved information on electron transport and plasmon excitation near the surface. Attosecond pulses cannot only probe electronic dynamics but also actively control and manipulate the electronic dynamics. Examples include the modification of the angular distribution of two-electron emission by variation of the attosecond pulse duration and the control of the emission direction in molecular break-up by unidirectional attosecond pulse trains.

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