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Real-time observation of attosecond and femtosecond quantum dynamics using ultrafast lasers

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Recent innovations in ultrafast laser technology have led to generation of intense near-infrared (NIR) laser pulses in the few-cycle regime, which implies light pulses as short as 5-10 fs. These pulses offer an exciting opportunity to perform real-time measurements of the fast quantum dynamics occurring in gaseous and condensed phase matter. Experiments using such techniques can time-resolve the electronic, nuclear and correlated motions inside atoms, molecules and solids. In particular, the interaction of intense ultrafast laser pulses with noble gases can be used to generate coherent extreme ultraviolet (XUV) pulses with temporal duration as short as 100 attoseconds. As a comparison, the Bohr timescale of electron in a Hydrogen atom is $\sim$ 150 attoseconds. Thus, a pump-probe scheme consisting of attosecond XUV pulses and intense femtosecond NIR laser pulses has opened up the doors for excitation and control of extremely fast electronic processes. I will describe some of our work which uses these techniques to probe inner-shell ionized and highly-excited electron dynamics in atoms and molecules.