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Attosecond pulse train control of strong field processes[1]

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Attosecond pulse trains (APTs) are a natural tool for studying and controlling strong field processes driven by an infrared (IR) laser. This control originates in the short duration of the individual pulses in the train, and their periodicity, which is half the IR laser period. This allows us to fix the ionization to a particular point in each IR half cycle and to select which quantum paths are available for the ionized electron to follow. This splitting of responsibilities: the APT drives the ionization and the IR laser drives the continuum dynamics, is, we will argue, a valuable new paradigm in strong field physics. In this talk we present calculations that demonstrate these principles by manipulating the time-frequency properties of high order harmonics at the single atom level. Solutions of the time-dependent Schrödinger equation for a helium atom subject to a combined APT/IR field show that both the yield and the coherence properties of the harmonics are improved when the APT is timed to launch the electron along the shortest quantum path, which exhibits a slow phase dependence and therefore gives rise to well behaved harmonics. We have also carried out non-adiabatic phase matching calculations which demonstrate that there are phase matching conditions where the single atom quantum path selection has a very large impact on the macroscopic harmonic signal. Finally, we examine how the electron wave packet created by APT-driven ionization gains energy from a strong IR laser field. In particular, we show that both the timing and the time-frequency characteristics of the APT influence the energy-resolved angular distributions of the ionized electrons.

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