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Attosecond Science at the Linac Coherent Light Source

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The motion of electrons in molecules and solids occurs on the sub-femtosecond timescale. Consequently, the study of ultrafast electronic phenomena with pump/probe experiments requires the generation of laser pulses shorter than 1 fs and of sufficient intensity to interact with their target with high probability. Since the first lasing of the Linac Coherent Light Source much progress has been made to improve the time resolution of X-ray free-electron laser (XFEL) experiments, reducing it by one order of magnitude over the initial 100 fs resolution. In my talk I will discuss the frontier of time-resolved pump/probe experiments with XFELs: the attosecond regime. I will present our recent experimental results on attosecond pulse generation[1] as well as the use of attosecond pulses for non-linear X-ray spectroscopy, photoemission delay measurements and single-shot imaging. I will also discuss our ongoing efforts to perform the first X-ray attosecond pump/probe experiments at LCLS-II using two-color attosecond X-ray pulses[2] and electron beam-based techniques. 1) Duris, J., Li, S., Driver, T. et al. Tunable isolated attosecond X-ray pulses with gigawatt peak power from a free-electron laser. Nat. Photonics 14, 30–36 (2020) 2) Zhang, Zhen, et al. "Double chirp-taper x-ray free-electron laser for attosecond pump-probe experiments." Physical Review Accelerators and Beams 22.5 (2019): 050701.