Transient Attosecond Soft-X-Ray Spectroscopy in Layered Semi-Metals

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X-ray absorption fine-structure (XAFS) spectroscopy is a well-established technique capable of extracting information about a material's electronic and lattice structure with atomic resolution. While the near-edge region (XANES) of a XAFS spectrum provides information about the electronic configuration, structural information is extracted from the extended XAFS (EXAFS) spectrum, consisting of several hundreds of eV above the absorption edge. With the advent of high harmonic sources, reaching photon energies in soft x-ray (SXR) region, it now becomes possible to connect the spectroscopic capabilities of XAFS to the unprecedented attosecond temporal resolution of a high harmonic source allowing the observation of electronic and lattice dynamics in real time [1,2].

Layered materials, such the transition-metal dichalcogenide TiS₂ or graphite, are an emerging class of materials with attractive structural and electronic properties as they can be thinned to a single atomic layer with electron mobilities resembling that of a metal, semiconductor, or semi-metal.

In this work, we utilized broadband water-window-covering attosecond SXR pulses (300 as, ranging from 200 - 550 eV) capable of accessing orbital-specific K- and L-edges of such layered materials to perform transient XAFS with attosecond time resolution [3,4].

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[2] Cousin S. et al, "Attosecond streaking in the water window: a new regime of attosecond pulse characterization", Phys. Rev. X, **7**, 041030 (2017).

[3] Buades, B. et al., "Dispersive soft x-ray absorption fine-structure spectroscopy in graphite with an attosecond pulse", Optica **5** (5), 502 (2018).

[4] Buades, B. et al., "Attosecond-resolved petahertz carrier motion in semi-metallic TiS₂", arXiv: 1808.06493 (2018).