Helicity and polarization control of high order harmonics

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Angular momentum can be routinely transferred to visible/infrared (IR) light beams using waveplates, or spatial light modulators, among other techniques. However, it becomes a lot harder in the extreme-ultraviolet (EUV) and x-ray regimes, where those techniques are highly inefficient. Imprinting spin (SAM) and/or orbital (OAM) angular momentum into the EUV/x-ray regimes will bring the applications of structured light down to the nanometric and ultrafast scales. The extreme nonlinear frequency upconversion of an intense IR femtosecond laser pulse through high harmonic generation (HHG) has become a powerful technique to imprint and control polarization—SAM—and vorticity—OAM—properties onto the EUV regime [1,2].

This talk reviews recent work in the control of the angular momentum properties (SAM and/or OAM) of coherent, EUV high-harmonic beams. By harnessing the quantum coherence of HHG, all-optical SAM-OAM that allows for unique control over the polarization and vorticity of attosecond beams [3], and macroscopic build-up of spatially polarization fields allows for the generation of isolated, circularly polarized isolated attosecond pulses [4]. These works, together with other techniques where vector field and circularly polarized harmonics are obtained [5-7], open the route to perform ultrafast studies of magnetic materials and chiral systems.

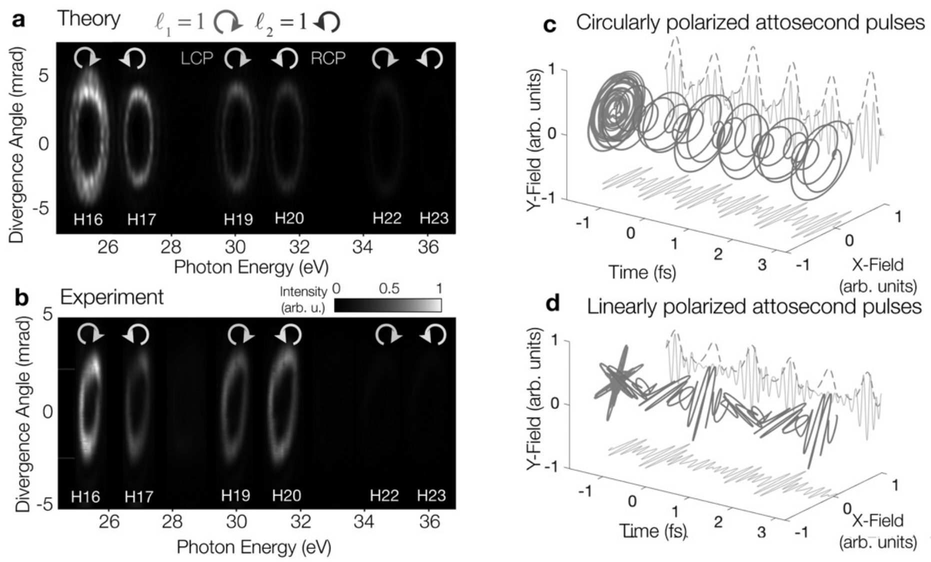

Figure 1: Simulated (a) and experimental (b) HHG spectra of circularly polarized vortex beams through HHG. By harnessing the angular momenta of the driving pulses, circularly (c) to linearly (d) polarized attosecond pulses obtained [3].

[1] Simpson E R and Mauritsson J 2018 *Nature Photonics* **12** 316
[2] Hernández-García C 2017 *Nature Physics* **13** 327
[3] Dorney K M *et al* 2019 *Nature Photonics* **13** 123–130
[4] Huang P-C *et al* 2018 *Nature Photonics* **12** 349–354
[5] Hernández-García C *et al*. 2017 *Optica* **4** 2334–2536
[6] Ellis J *et al*. 2018 *Optica* **5** 479–485
[7] Azoury D *et al*. 2019 *Nature Photonics* **13** 198–204