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Attosecond pulses and high-order harmonics with controllable spin and orbital angular momentum.

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Angular momentum can be routinely transferred to visible/infrared 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 inefficient. This challenging goal is very much worth the effort: 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 SAM and OAM onto the EUV regime. This talk reviews our recent work in the generation of coherent, EUV high-harmonic beams and attosecond pulses with full, simultaneous control of both spin angular momentum (SAM) and orbital angular momentum (OAM). By harnessing the quantum coherence of HHG, we uncover a new form of all-optical SAM-OAM interplay showing, experimentally and theoretically, that this phenomenon allows for unprecedented control over the polarization and vortex charge of attosecond EUV vortex beams. This work paves the way to perform ultrafast studies of magnetic materials and chiral systems at the subfemtosecond and nanometer scales.