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Synthesis and characterization of attosecond light vortices in the extreme ultraviolet

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Infrared and visible light beams carrying orbital angular momentum (OAM) are currently thoroughly studied for their extremely broad applicative prospects, among which are quantum information, micromachining and diagnostic tools. Here we extend these prospects, presenting a comprehensive study for the synthesis and full characterization of optical vortices carrying OAM in the extreme ultraviolet (XUV) domain. We confirm the upconversion rules of a femtosecond infrared helically phased beam into its high-order harmonics, showing that each harmonic order carries the total number of OAM units absorbed in the process up to very high orders (57). This allows us to synthesize and characterize helically shaped XUV trains of attosecond pulses. To demonstrate a typical use of these new XUV light beams, we show our ability to generate and control, through photoionization, attosecond electron beams carrying OAM. These breakthroughs pave the route for the study of a series of fundamental phenomena and the development of new ultrafast diagnosis tools using either photonic or electronic vortices.

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