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Frequency combs and precision spectroscopy in the extreme ultraviolet

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Development of the optical frequency comb has revolutionized optical metrology and precision spectroscopy due to its ability to provide a precise link between microwave and optical frequencies. A novel application that aims to extend the precision and accuracy obtained to the extreme ultraviolet (XUV) is the generation of XUV frequency combs via intracavity high harmonic generation (HHG). Recently, we have been able to generate > 200 μW average power per harmonic and demonstrate the comb structure of the high harmonics by resolving atomic argon and neon lines at 82 and 63 nm, respectively [1]. The argon transition linewidth of 10 MHz, limited by residual Doppler broadening, is unprecedented in this spectral region and places a stringent upper limit on the linewidth of individual comb teeth. To overcome this limitation, we have constructed two independent intracavity HHG sources to study the phase coherence directly via the heterodyne beats between them. With these developments, ultrahigh precision spectroscopy in the XUV is within grasp and has a wide range of applications that include tests of bound state quantum electrodynamics, development of nuclear clocks, and searches for variation of fundamental constants using the enhanced sensitivity of highly charged ions.

[1] Arman Cingöz et al., Nature **482**, 68 (2012).

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