

# Capturing the Fastest Charge and Spin Dynamics in Nanosystems using High Harmonic Beams

M. Murnane\*

*JILA, University of Colorado, Boulder, CO 80309-0440*

High harmonic generation (HHG) is a unique quantum light source with fundamentally new capabilities – producing fully spatially and temporally coherent beams with linear or circular polarization throughout the extreme ultraviolet (EUV) and soft X-ray region, all on a tabletop. This talk will introduce and review recent developments in HHG sources, as well as exciting advances in imaging and spectroscopy of materials. It is now possible to image below the wavelength limit in the EUV/x-ray region for the first time, by combining HHG sources with coherent diffractive imaging (CDI) techniques. Moreover, in recent work we measured the shortest lifetime of any state to date, at  $212\pm 30$  attoseconds, corresponding to an excited state in the band structure of a material. More recently, in particular, a new technique called attosecond-ARPES (angle resolved photoemission) harnesses HHG pulse trains to measure the fastest electron dynamics intrinsic to materials, making it possible to distinguish sub-femtosecond electron scattering and screening for the first time. Finally, bright, phase matched, circularly and linearly polarized HHG now span from the EUV to the soft X-ray region at kHz repetition rates, ideally suited for a host of applications in science and technology. [1,2,3,4,5].

## References:

- [1] Science 353, 62 (2016)
- [2] Nature Photonics (2017)
- [3] PNAS 112, 4846–4851 (2015)
- [4] Physical Review Letters 110, 197201 (2013)
- [5] Science 348, 530 (2015)