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Abstract for an Invited Paper
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Science at the Time-scale of the Electron

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Replace this text with your abstract Ever since the invention of the laser 50 years ago and its application in nonlinear optics, scientists have been striving to extend coherent laser beams into the x-ray region of the spectrum. Very recently however, the prospects for *tabletop* coherent sources, with attosecond pulse durations, at very short wavelengths even in the hard x-ray region of the spectrum at wavelengths $<$ 1nm, have brightened considerably. These advances are possible by taking nonlinear optics techniques to an extreme, and are the direct result of a new ability to manipulate electrons on the fastest, attosecond, time-scales of our natural world. My talk will discuss new experimental data that demonstrates high harmonic generation of laser-like, fully coherent, 10 attosecond duration, soft x-ray beams at photon energies around 0.5keV. Several applications will also be discussed, including making a movie of how electron orbitals in a molecule change shape as a molecule breaks apart, following how fast a magnetic material can flip orientation, understanding how fast heat flows in a nanocircuit, or building a microscope without lenses.

[1] T. Popmintchev et al., "Phase matched upconversion of coherent ultrafast laser light into the soft and hard x-ray regions of the spectrum", PNAS **106**, 10516 (2009).
[2] C. LaOVorakiat et al., "Ultrafast Soft X-Ray Magneto-Optics at the M-edge Using a Tabletop High-Harmonic Source", Physical Review Letters **103**, 257402 (2009).
[3] M. Siemens et al. "Measurement of quasi-ballistic heat transport across nanoscale interfaces using ultrafast coherent soft x-ray beams", Nature Materials **9**, 26 (2010).
[4] K. Raines et al., "Three-dimensional structure determination from a single view," Nature **463**, 214 (2010).
[5] W. Li et al., "Time-resolved Probing of Dynamics in Polyatomic Molecules using High Harmonic Generation", Science **322**, 1207 (2008).