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Using cavity-enhanced high harmonic generation to track electrons in solids

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Time-resolved photoemission spectroscopy (tr-PES) has become a key technique for studying the non-equilibrium electronic structure of molecules and solids, vibrational dynamics in molecules as well as physics/chemistry of surfaces. By adding angle-resolved capabilities (i.e., tr-ARPES), the dynamical behavior of electronic band dispersion in solids can be observed, enabling the interplay of electrons, phonons, and spin dynamics to be disentangled. While the capabilities of electron analyzers has improved drastically over the past two decades, ultrafast photon sources for tr-ARPES have remained a major technical limitation. Addressing these shortcomings, I will discuss our recent demonstration of a new laser-based, 60-MHz femtosecond XUV source —based on cavity-enhanced high harmonic generation— that has enabled coverage over the full Brillouin Zone (>2 Angstrom^{-1} $with a time (energy) resolution of 190 fs (22 meV). I will summarize our characterization measurements (on a topological insulator, Bi_2Se_3,$ and polycrystalline Au) and present results of measuring electron-phonon coupling in graphite at the edge of its Brilliouin Zone. I will also discuss our future plans enabled by this next generation TR-ARPES source.