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Ultrafast Coherent Photoelectron Spectroscopy of Electronic States on a Cu (111) Surface ADRA CARR, CONG CHEN, ZHENSHENG TAO, MARGARET MURNANE, HENRY KAPTEYN, PIOTR MATYBA, JILA/ NIST, SEBASTIAN EMMERICH, MARTIN AESCHLIMANN, University of Kaiserslautern, Germany, ULRICH HOEFER, University of Marburg, Germany
— We use laser-assisted high-harmonic time- and angle-resolved photoemission to directly observe coherent photoemission from a Cu(111) metal surface and the interferences between the emitted photoelectron wavepackets. A comb of high harmonics in combination with interferometrically timed infrared pulses enable a powerful combination of attosecond time resolution and high energy resolution, making it possible to extract phase information about the emitted photoelectron wavepackets and the distinct electronic states from which they emerge. By comparing photoemission from the well-known Shockley surface state to the sp and d bulk bands of Cu(111), we can observe non-negligible phase shifts in the emitted wavepackets, which cannot be attributed to time delays resulting from classical electron transport to the surface. Rather, we interpret these phase shifts as due to an intrinsic photoemission phase that is different for the sp and d band wavefunctions, thus providing a physical interpretation of temporal delays observed in photoemission from surfaces.

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