Quantum state tomography of photoelectrons

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Photoelectrons created by absoprtion of ultrashort XUV pulses can be mixed quantum states, which requires quantum state tomography (QST) to be fully characterized. In this work we experimentally demonstrate a QST protocol, KRAKEN, [1] and measure the density matrices of photoelectrons emitted from helium, neon and argon atoms, shown in Fig.1. We measure a reduced purity of the photoelectron in the case of neon and argon, due to the spin-orbit interaction. Since the ionizing radiation can be assumed to be fully coherent, the reduced purity implies entanglement between the ion and the photoelectron. KRAKEN is a new tool that enables to measure the quantum state of photoelectrons on ultrashort timescales with potential applications in atomic, molecular and solid state systems.

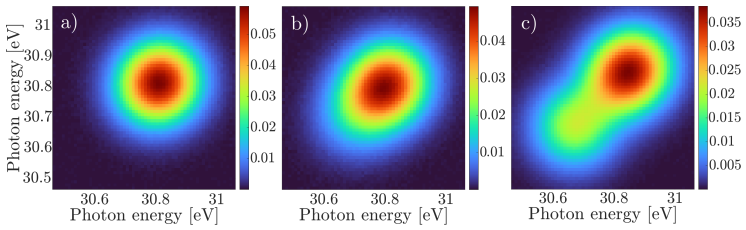

Figure 1: Reconstructed amplitude of density matrices for photoelectrons ejected from helium a), neon b) and argon c) atoms using KRAKEN.

References

[1] Laurell *et. al.*, Continuous-variable quantum state tomography of photoelectrons, Phys. Rev. Research **4**, (2022) 033220