Circular Dichroism in the Multi-Photon Ionization of Oriented Helium Ions

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Synopsis Intense, circularly polarized extreme-ultraviolet (XUV) and near-infrared (NIR) laser pulses are combined to double-ionize atomic helium via the oriented intermediate $He^+(3p)$ resonance state. A strong and NIR-intensity dependent circular dichroism is accounted to a helicity dependent AC-Stark shift.

The dichroic interaction of circularly polarized X-rays with matter is a multi-disciplinary field of science. With the advent of circularly polarized free-electron lasers (FELs) [1, 2], the research field of circular dichroism phenomena in non-linear and ultrafast physics has been extended to the soft X-ray regime. Using high intensity, narrow bandwidth XUV pulses from FERMI in Italy with a photon energy of 48.4 eV, we were able to first ionize and subsequently orient ionic helium in the 3p (m=+1) magnetic substate. From there, the population of this state was controlled by a helicity-dependent AC Stark shift generated by an overlapped near-infrared laser. The measured circular dichroism of electrons emitted via multi-photon ionization of the ionic 3p state is intensity dependent to a surprisingly strong extent, therefore allowing for an easily controllable and polarization selective transparency of such resonances [3]. The experimental results depicted in Fig. 1 are in excellent agreement with two independent calculations based on the Time Dependent Schrödinger Equation (TDSE) [4, 5]. Potential applications in the general context of chirality research at FELs will be presented.

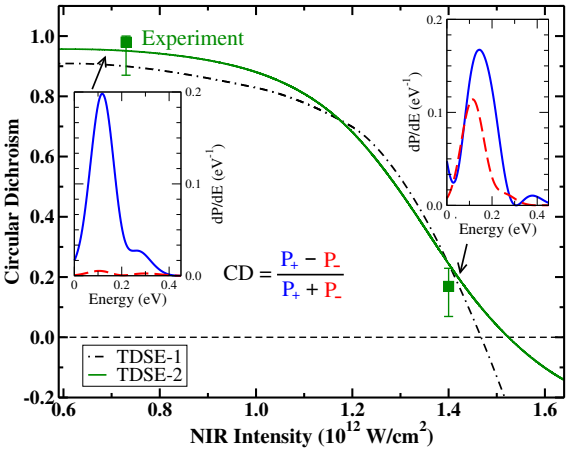

Figure 1. Circular dichroism for electrons ejected from the oriented $He^+(3p)$ state after multi-photon absorption (E_{kin} ≈200 meV) as function of the NIR peak intensity [3].

References

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