j-resolved measurement of spin polarized electrons produced by strong-field ionization

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Synopsis We present *j*-resolved experimental data on the spin polarization of electrons created by strong-field ionization of noble gas atoms in an intense 400 nm circularly polarized laser field.

As a fundamental property of the electron the spin plays an important role in the buildup of atoms, matter and its macroscopic properties, e.g. magnetism. Hence studying effects regarding the spin is highly interesting. In the field of strong-field physics however the role of the spin remains largely unexplored so far. A few pioneering theoretical works have investigated electron spin dynamics in strong laser fields [1-4]. As is described in [1] the tunnel ionization probability for circular light is dependent on the magnetic quantum number m_l. In combination with spin-orbit-interaction (energy splitting of different *j*-states) this leads to spin polarization of electrons created by strong-field ionization of noble gas atoms. Corresponding theoretical calculations are shown in Fig. 1.

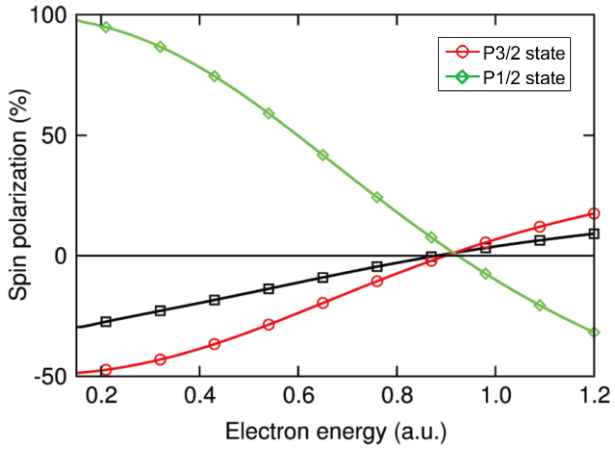

Figure 1. Calculated spin polarization of photoelectrons emitted from krypton dependent on their kinetic energy. A circularly polarized 800nm laser with $I = 1.8 \cdot 10^{14}$ W/cm² was used for the simulation. Green curve with diamonds resolved on the $^2P_{1/2}$ state of the core; Red curve with circles resolved on $^2P_{3/2}$; Black curve with squares integrated over core states. From [1]

Lately a first experimental study by Hartung *et al.* [5] confirmed the existence of energy-dependent spin polarization in strong-field ionization using 800 nm circular laser light.

Here we present new experimental data, being able to resolve the initial total angular momentum *j*. Xenon was ionized with an 400 nm, 40fs, circularly polarized laser at $5.4 \cdot 10^{13}$ W/cm². A Mott detector was used for the measurement of the electron spin. The *j*-dependent degree of spin polarization as well as the energy dependence of the effect shown in Fig. 2 are in good qualitative agreement with theory (Fig. 1).

Theoretical calculations matching our laser parameters and atomic species are in progress to allow for quantitative comparison.

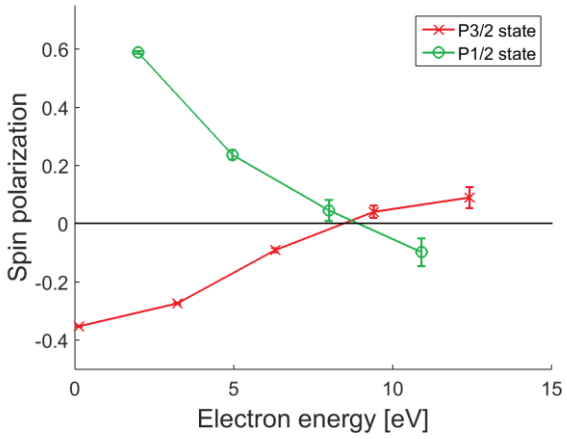

Figure 2. Measured *j*-resolved spin polarization of photoelectrons emitted from Xenon dependent on their kinetic energy. Green circles corresponding to the $^2P_{1/2}$ state of the core; red marks corresponding to $^2P_{3/2}$.

References

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