Nonsequential Double Ionization by Counterrotating Circularly Polarized Two-Color Laser Fields

Sebastian Eckart* [1], Martin Richter*, Maksim Kunitski*, Alexander Hartung*, Jonas Rist*, Kevin Henrichs*, Nikolai Schlott*, Huipeng Kang*, Tobias Bauer*, Hendrik Sann*, Lothar Ph. H. Schmidt*, Markus Schöffler*, Till Jahnke* and Reinhard Dörner*

* Institut für Kernphysik, Goethe-Universität Frankfurt, 60438 Frankfurt am Main, Germany

Synopsis A detailed study of recolliding electrons in counterrotating two color laser fields is presented. It is shown that the nonsequential double ionization yield strongly depends on the field ratio.

Using counter rotating circular two-color fields (CRTC) well controllable waveforms can be generated [1,2]. CRTC fields can initially drive electrons away from the atom but later drive them back which can be used to generate high harmonics [3]. We conclude that double ionization is driven by a beam of nearly monoenergetic recolliding electrons,

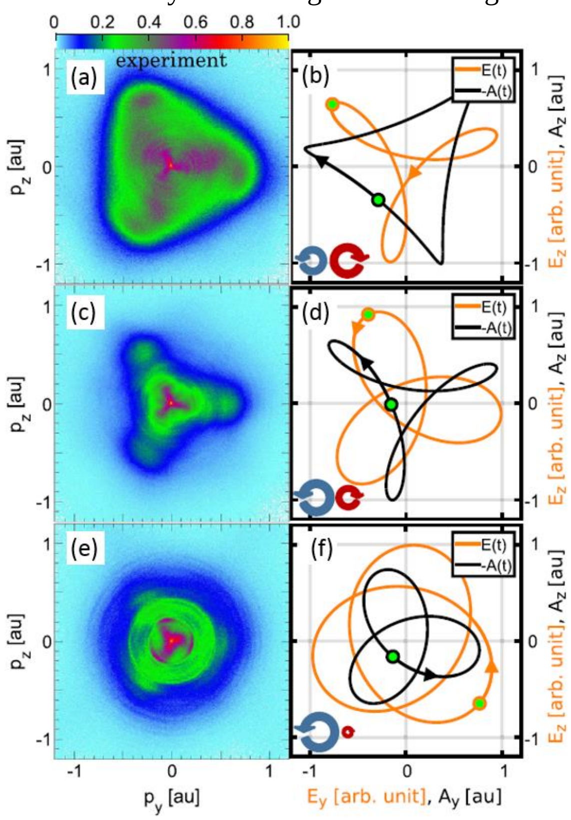

Figure 1. In (a), (c), (e) measured electron momentum distributions are shown for the field ratios E_{390}/E_{780} of (a) 0.8:1, (c) 1.5:1, and (e) 3.5:1 and a maximum combined intensity of 5.0 × 10^{14} W/cm^2. The helicities and the temporal development of the electric fields and the vector potentials are indicated with arrows. The energy needed for double ionization (27.6 eV) and the relevant excitation energy (17.14 eV) are marked with dashed orange and red lines, respectively.

which can be controlled in intensity and energy by the field parameters [4-6]. The electron momentum distributions show the recolliding electron as well as a second electron which escapes from an intermediate excited state of Ar+. The three-dimensional electron momenta have been measured in coincidence with their ionic cores using cold-target recoil-ion momentum spectroscopy (COLTRIMS) [7].

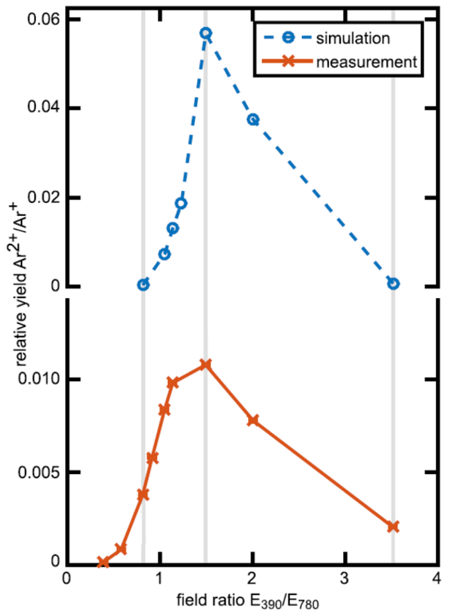

Figure 2. The measured and simulated relative yield of double to single ionization (a) which strongly depend on the field ratio E_{390}/E_{780}.

References

[1] C. A. Mancuso *et al.* (2015) *Phys. Rev A* **91** 031402(R)

[2] W. Becker *et al.* (1999) *Phys. Rev. A* **60** 1721-1722

[3] A. Fleischer *et al.* (2014) *Nature Photonics* **8** 543-549

[4] J. L. Chaloupka and D. D. Hickstein (2016) *Phys. Rev Lett.* **116** 143005

[5] C. A. Mancuso *et al.* (2016) *Phys. Rev Lett.* **117** 133201

[6] S. Eckart *et al.* (2016) *Phys. Rev Lett.* **117** 133202

[7] O. Jagutzki *et al.* 2002 *IEEE Transactions on Nuclear Science* **49** 2477-2483

[1] E-mail: eckart@atom.uni-frankfurt.de