Two-center interferences in atomic RABBITT-like experiments

Diego I.R. Boll[*1], **Omar A. Fojón**[*†2]

[*] Instituto de Física Rosario, CONICET-UNR Blvd. 27 de Febrero 210 bis, 2000 Rosario, Argentina.
[†] Escuela de Ciencias Exactas y Naturales, FCEIA, Universidad Nacional de Rosario, Argentina.

Synopsis We study theoretically the angular distributions of photoelectrons for the laser assisted photoionization of atomic targets by trains of attosecond pulses. We employ a non-pertubative model that under certain approximations gives closed form expressions for the observables of the reaction.

Since 2001, when the first attosecond pulses were obtained [1, 2], the branch of science called attophysics has grown vigorously. Among the different techniques developed in the last sixteen years the so called reconstruction of attosecond bursts by interferences of two-photon transitions (RABBITT) has played a crucial role in those achievements. In this scheme an atomic or molecular target is ionized by a train of attosecond pulses in the presence of a near infrared assistant laser field (NIR) of low intensity. These attosecond pulse trains (ATPTs) are routinely obtained by means of the high-order harmonic generation technique in which a strong ultrashort laser pulse in the near infrared is focused into a noble gas atom chamber. The simplest attosecond pulse trains have a frequency spectrum containing only the odd harmonics of a given fundamental frequency. As a consequence of the frequency spectrum of the ATPT and the low intensity of the assistant laser field, the photoelectron spectrum for a RABBITT scheme presents dressed harmonic lines populated by the single-photon ionization of the target. Additionally, and between adjacent dressed harmonic lines, the spectrum displays sideband lines. As these sidebands are populated by wavepackets that follow different quantum paths, they will interfere constructively or destructively according to the delay between the ATPT and the NIR.

For a low intensity NIR, these features of the photoelectron spectrum may be explained by a second-order perturbative model [1]. However, recent experimental and theoretical results [3] have shown that second-order models may not be able to describe the observables for these reactions when the intensity of the assistant laser field is increased, due to the presence of continuum-continuum transitions of order higher than one.

As we showed recently [4, 5] by means of an extension of the Separable Coulomb-Volkov model, it is possible to obtain analytical expressions describing the photoelectron angular distributions in RABBITT-like experiments, where the interaction of the photoelectron and the NIR is treated to all orders. Interestingly, our model indicates that the angular distributions for atomic targets assume the same functional form corresponding to the monochromatic photoionization of molecular targets, as given by Cohen and Fano [6, 7], with a separation vector between virtual emitters governed by the infrared laser field.

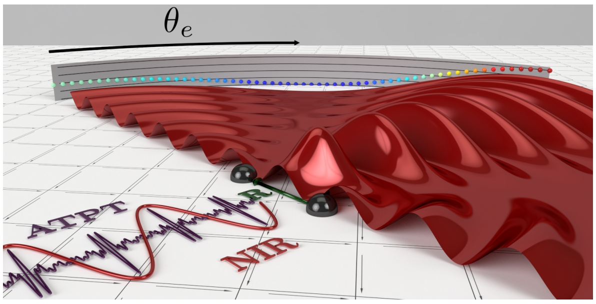

Figure 1. Schematic representation of the RABBITT-like reaction for an atomic target. θ_e represents the photoelectron emission angle as measured from the ATPT polarization direction. The vector **R** is the separation between the virtual emitters predicted by our model.

In this contribution, we study the photoelectron angular distributions corresponding to RABBITT-like experiments. We compare the results of our model with recent experimental results and discuss the possible mechanism for the control of photoelectron emission.

[1]E-mail: boll@ifir-conicet.gov.ar
[2]E-mail: fojon@ifir-conicet.gov.ar

References

[1] P. M. Paul *et al.* 2001 *Science* **292** 1689

[2] M. Hentschel *et al.* 2001 *Nature* **414** 509

[3] Y. J. Picard *et al.* 2014 *Phys. Rev. A* **89** 031401(R)

[4] D.I.R. Boll *et al.* 2016 *J. Phys. B: At. Mol. Opt. Phys.* **49** 185601

[5] D.I.R. Boll *et al.* 2017 *J. Phys. B: At. Mol. Opt. Phys.* **50** 055604

[6] H.D. Cohen *et al.* 1966 *Phys. Rev.* **150** 30

[7] M. F. Ciappina *et al.* 2014 *J. Phys. B: At. Mol. Opt. Phys.* **47** 042001