Journal of Physics: Conference Series

PAPER • **OPEN ACCESS**

Probing Xe electronic structure by two-color HHG

To cite this article: D Faccialà *et al* 2015 *J. Phys.: Conf. Ser.* **635** 092100

XXIX International Conference on Photonic, Electronic, and Atomic Collisions (ICPEAC2015) IOP Publishing
Journal of Physics: Conference Series **635** (2015) 092100 doi:10.1088/1742-6596/635/9/092100

Probing Xe electronic structure by two-color HHG

D. Faccialà[a], S. Pabst[b], B. D. Bruner[c], A. G. Ciriolo[a], S. De Silvestri[a], M. Devetta[a], N. Dudovich[c], M. Negro[a], H. Soifer[c], S. Stagira[a] and C. Vozzi[a 1]

[a] CNR–IFN & Politecnico di Milano (Italy)
[b] Center for Free-Electron Laser Science DESY (Germany) & ITAMP Harvard-Smithsonian Center for Astrophysics (USA)
[c] Department of Physics of Complex Systems, Weizmann Institute of Science (Israel)

Synopsis The aim of this study is probing the multi-electron behavior in xenon by two-color driven high harmonic generation. By changing the relative polarization of the two colors we were able to study different aspects of the multi-electron response.

We investigated the giant resonance in xenon [1, 2] by high-order harmonic generation (HHG) driven by a two-color field ($\lambda_1 = 1550\,\text{nm}$ and its second harmonic). We acquired HHG spectra as a function of the phase difference between the two colors, in two polarization configurations: parallel and orthogonal. The ratio between the second harmonic and the fundamental field was ≈ 0.4 for parallel polarization and ≈ 0.1 for perpendicular polarization. In parallel configuration, the presence of the second harmonic component produces two sets of trajectories with two different cutoffs: the upper branch corresponding to the more energetic trajectories and the lower branch, corresponding to the less energetic trajectories [4]. In the single active electron picture (SAE), the ionization probability of the upper branch is suppressed and only the lower branch is visible in the HHG spectrum. In our experimental results (fig. 1a) the upper branch is clearly visible, revealing an enhancement of the contribution of the more energetic trajectories with respect to SAE predictions. Theoretical calculations confirm this picture: the upper branch is not visible in the HHG spectrum in SAE (fig. 1b), while it appears when multi-electron effects are taken into account (fig. 1c). In orthogonal configuration the second harmonic acts as a displacement gate which selects specific continuum electron trajectories, depending on the relative phase between the two colors [3]. The HHG scan is reported in fig. 1d colormap along with the phase difference ϕ that maximizes harmonic emission for each harmonic order (red line). The theoretical expectation in the SAE approximation for ϕ is represented by the blue line in fig. 1d. A comparison between the two curves reveals two aspects: 1) the giant resonance increases the harmonic yield in the spectral region between 60 and 140 eV, allowing to observe the contribution of trajectories beyond the cutoff (70 eV); 2) the discrepancy between the experiment and the SAE model in the energy region corresponding to the giant resonance can be related to a change in the electron recombination time due to the collective electron correlation.

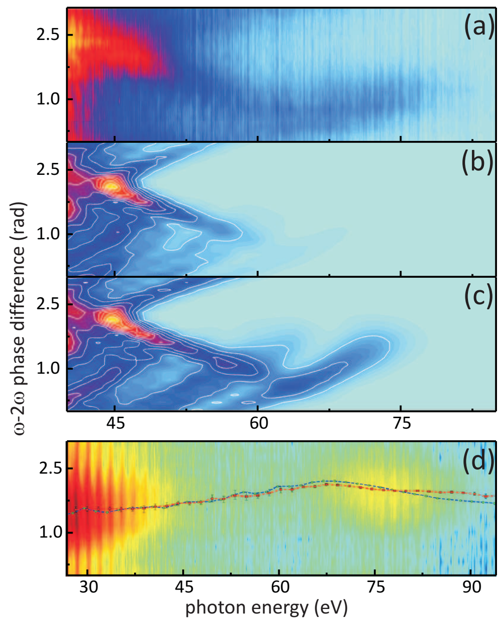

Figure 1. HHG scan in xenon as a function of ϕ. Parallel configuration: experiment (a) and Time-Dependent Configuration-Interaction Singles calculations without (b) and with (c) the contribution of electron correlation (linear scale). (d) Orthogonal configuration: harmonic spectra (colormap - log scale), experimental phase ϕ (red curve), SAE phase ϕ (blue curve).

References

[1] A. D. Shiner *et al* 2011 *Nat. Physics* **7** 464

[2] S. Pabst *et al* 2013 *Phys. Rev. Lett.* **111** 233005

[3] D. Shafir *et al* 2012 *Nature* **485** 343

[4] M. V. Frolov *et al* 2010 *Phys. Rev. A* **81** 063407

[1]E-mail: caterina.vozzi@polimi.it