Continuum-continuum transitions between resonant states using the RABITT technique

To cite this article: A Jiménez *et al* 2014 *J. Phys.: Conf. Ser.* **488** 022014

Journal of Physics: Conference Series **488** (2014) 022014 doi:10.1088/1742-6596/488/2/022014

Continuum-continuum transitions between resonant states using the RABITT technique

A. Jiménez*, **L. Argenti*** [1], **F. Martín*** †

* Departamento de Química, Módulo 13, Universidad Autónoma de Madrid, 28049 Madrid, Spain

† Instituto Madrileño de Estudios Avanzados en Nanociencia (IMDEA-Nanociencia), Cantoblanco, 28049 Madrid, Spain

Synopsis We present a study of radiative continuum-continuum transitions in helium in the presence of doubly-excited states by using the attosecond RABITT technique beyond the Single Active Electron approximation. On the one hand, transition amplitudes between correlated continuum states are calculated both by direct numerical solution of the time-dependent Schrödinger equation as well as with a two-photon perturbative model. The effect of autoionizing states on the sideband phaseshift is thus analyzed. On the other hand, we apply the soft-photon approximation to quantify the effects the IR probe intensity on the sideband non-resonant overtone components.

We present a theoretical study of two-photon continuum-continuum transitions in helium in energy regions where resonant doubly excited states are present, using the attosecond XUV pulse train (APT) pump - IR probe technique known as RABITT (Reconstruction of Attosecond Beating by Interference of Two-photon Transitions) [1]. Contrary to its initial purpose, which was to assume slowly varying atomic transition matrix elements to reconstruct, from the phaseshifts between consecutive sidebands in the photoelectron spectrum, the profile of an XUV train [2], we assume here that the train parameters are known, and use this technique to extract information on the phases of atomic amplitudes instead. This way, we can recover two-photon transition matrix elements between correlated continuum states, which give insight on electron-electron interaction.
Our results are based on the essentially exact *ab-initio* direct solution of the time-dependent Schrödinger equation for the helium atom in a close-coupling B-spline basis with an Arnoldi propagator in a quantization box [3] under the action of realistic external pulses, as well as on the comparison with the prediction of a parametrized two-photon perturbative model.

Parallel and complementary to this work, we apply the Soft Photon Approximation [4] to the APT-pump IR-probe scheme to study the effects probe intensity has on sideband overtone components. We derive universal limiting analytical expressions for the dependence of the overtone intensity on the intensity of the dressing field. Qualitative departure from the perturbative regime is predicted already at intensities as low as $5 \cdot 10^{11}$ W/cm^2, where multiphoton contributions can start to dominate, and should be experimentally observable with most realistic finite pulses.

References

[1] P. M. Paul *et al.* 2001 *Science* **388** 1689

[2] R. López-Martens *et al.* 2005 *Phys. Rev. Lett.* **94** 033001

[3] L. Argenti and E. Lindroth 2010 *Phys. Rev. Lett.* **105** 053002

[4] A. Maquet and R. Taïeb 2007 *J. Mod. Opt.* **54** 1847

[1] E-mail: luca.argenti@uam.es