The RMT approach to calculate anisotropy parameters for sidebands in two-colour two-photon ionisation of helium

H. F. Rey[1], L. R. Moore[1], M. A. Lysaght[1,2], J. S. Parker[1], H. W. van der Hart[1], and K. T. Taylor[1]

[1]*Center for Theoretical Atomic Molecular and Optical Physics, Queen's University Belfast, Belfast, BT7 1NN, United Kingdom*

[2]*ICHEC, Tower Building, Trinity Technology and Enterprise Campus, Grand Canal Quay, Dublin 2, Ireland*

h.rey@qub.ac.uk

Experimental light sources, capable of generating ultra-short laser pulses lasting just a fraction of a femtosecond, have recently been developed [1]. These light sources use a coherent superposition of high harmonics in the XUV regime. The ultra-short pulses can be analysed by overlapping the ultra-short pulse with a short pulse of the fundamental during ionisation. By irradiating an atom with XUV laser pulse and an IR dressing field, positive and negatives sidebands peaks will appear either side of the central single ionisation peak [2]. Experiments [3] have been recently carried out to measure the photoelectron angular distributions of such sidebands and can provide a test for evaluating theoretical models.

The theoretical and computational description of multielectron atoms in strong fields using the R-matrix theory has been an area of interest at Queen's University Belfast over the last 20 years [4,5,6]. The latest achievement is the RMT (R-matrix Incorporating Time dependence) approach, which extends R-matrix theory to the time domain. In the description of ultra-fast atomic dynamics, the RMT method combines a multi-electron B-spline R-matrix basis description within a spatial region surrounding the nucleus and a finite difference representation of the single-electron wavefunction at larger distances from the nucleus [7,8]. This method has been successful for calculation of time delays between photoemission of a 2s and a 2p electron from Ne [9].

We investigate ionisation of He irradiated by a combination of two laser pulses: an XUV pulse corresponding to the 17^{th} – 21^{st} harmonic of the fundamental laser field and an overlapping fundamental dressing field. The wavelength of the fundamental field ranges from 790 – 810 nm. We use the RMT approach to determine anisotropy parameters of the sidebands generated by the dressing field. We investigate how these parameters depend on the amount of atomic structure included in the theoretical model. We compare the calculated values obtained for the anisotropy parameters with those obtained experimentally [3].

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