Ejected electron momentum spectra for multiphoton ionisation of carbon

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Recent experimental developments in laser technology allow researchers to generate light pulses with durations in the sub-femtosecond time-scale (1 fs = 10^{-15} s), which is comparable to the time-scale of the motion of electrons [1]. This can lead to new interesting interplay between the light field and (multi)electron dynamics. In order to guide and interpret experiments, the theoretical and computational description of multielectron atoms in intense laser fields, also requires new methods to investigate this interplay on the sub-femtosecond timescale.

Over the past decade and more, researchers at Queen's University Belfast have developed a set of powerful computational codes to study ultrafast dynamics of multielectron systems exposed to intense short-duration light from first principles [2,3,4]. The most recent one is the RMT (R-matrix incorporating Time dependence) approach, which combines a basis-set technique surrounding the nucleus with a finite-difference approach at larger distances [5,6]. This code has been developed only recently, and has so far been applied to relatively simple systems (few target states, $^1S^e$ initial state) including the calculation of time delays between photoemission of a 2s and a 2p electron from Ne [7].

Previously, R-matrix calculations have been applied to obtain photoionisation cross sections for a wide range of atoms, including, for example carbon [8]. To extend these photoionisation studies to the time domain, we investigate multiphoton ionisation of C irradiated by a 390 nm laser pulse using the RMT approach. We investigate the convergence with angular momentum by increasing L systematically. Carbon provides a good test of the capabilities and the efficiency of the RMT method: many more ionisation channels are available, and the initial state has $^3P^e$ initial symmetry rather than $^1S^e$.

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