

Multi-electron effects in the photo-emission from few-electron systems He attoclock, IR-double emission, and molecular ionization

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Synopsis Multi-electron effects in the interaction of few-electron systems with light at visible to IR wave length are investigated. For He, full 6-dimensional calculations of photo-ionization spectra in near-circular polarized light at 800 nm wave length compare well with single-electron model calculations, showing the absence of correlation for the process. In IR double emission spectra, characteristic checkerboard patterns emerge due to Freeman-type resonances. Multi-electron effects are essential for the ionization of molecules as shown in *ab initio* ionization calculations.

We employ and extend recently developed theoretical tools for a systematic investigation of multi-electron effects. The tSURFF technique [1, 2] allows us study the single and double ionization of He at 800 nm wavelength and linear as well as elliptic polarization. For larger atoms and small molecules, we employ the “hybrid anti-symmetrized Coupled Channels” (haCC) approach [3], that combines internal dynamics in terms of quantum chemical states with full strong-field dynamics for valence electrons. The fact that haCC fully includes interactions and exchange ensures that correct *ab initio* results can be presented. It had been demonstrated earlier that inclusion of exchange during the dynamics is essential even for only qualitatively correct results [4].

For single-emission we corroborate emerging consensus that single-electron models fully capture the process by performing a haCC calculation [5] as well as a calculation in full 6 dimensions. The manifest discrepancy between all theoretical findings and the deflection angles reported in experiment [6] remains an open question.

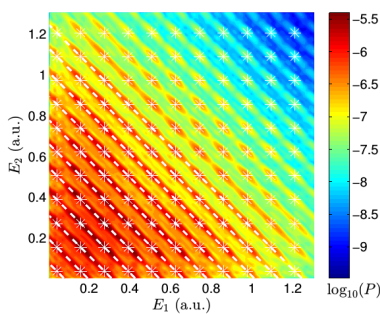


Figure 1. Double emission energy spectra at intensity $5 \times 10^{14} \text{ W/cm}^2$ and wavelength 390 nm. Stars mark emission peaks. The pattern was found to be universal.

A conspicuous checkerboard pattern (Fig. 1) found in calculations as well as in experiment [7] is traced back to Freeman type resonances, based on a Floquet

analysis. Impact on angular correlations in double-emission spectra will be reported.

Finally, haCC allows us to present dependable ionization rates and differential photo-emission spectra for a range of di- and tri-atomics such as N_2 , CO_2 , CO , and HeH^+ . In particular CO_2 and CO show pronounced, qualitative multi-electron effects, Fig 2.

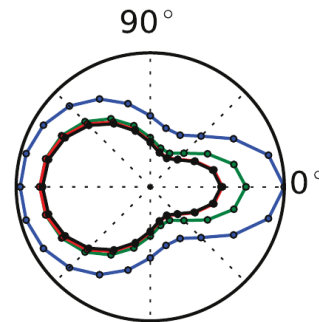


Figure 2. Ionization of CO at $9 \times 10^{13} \text{ W/cm}^2$: multi-electron effects (increasing from blue to black) enhance asymmetry of emission. Without them, the asymmetry parameter even changes sign at lower intensities.

The tRecX framework used for all calculations has been made available in public domain [8]. New features developed for the above applications will be presented at the conference.

References

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