Laser-Assisted Electron-Atom Radiative Recombination in Short Laser Pulses

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Electron recombination by an atomic target, which occurs in the presence of a strong laser field, is of fundamental importance for the development of strong-field physics and related areas such as attoscience. The point is that laser-assisted radiative recombination (LARR) is the underlying mechanism of high-order harmonic generation (HHG), which has played a pivotal role in developing nonlinear optics.

The ability to generate intense and coherent light with controllable properties is one of the most inspiring achievements of recent years. In light of this still undergoing progress, we analyze the laser-field aspects of the LARR process. For clarity, we focus on electron-atom recombination, which involves a short-range atomic interaction. In this context, we develop a comprehensive theoretical approach to describe LARR [1], which explicitly accounts for contributions from the field-free and the field modified processes. This is in contrast to the previous works, where the bandwidth-limited probability amplitude of LARR has been calculated. Also, we consider an initial electron wave packet with momentum distribution that allows to smear out the field-free divergence. While our theory accounts for an arbitrary laser field, we illustrate it for isolated pulses and pulse trains. We observe a coherent enhancement of the LARR spectra for the latter. More specifically, the comb structures in the spectra appear with the intensity that scales quadratically with the number of pulses in a train. This makes a promise to synthesize the LARR radiation into short pulses. Another aspect of our investigations relates to the temporal reconstruction of the laser field. More specifically, our time-frequency analysis of the LARR spectra demonstrates a possibility of *in situ* measurement of the laser field. The method is insensitive to the parameters of the field and can be used for the metrology of both isolated pulses and pulse trains. Therefore, proving its great versatility.

References

[1] D Kanti, J Z Kamiński, L-Y Peng and K Krajewska, New J. Phys. (2021), submitted