OPTIMAL CONTROL WITH REALISTIC PULSES – THE PHOTOELECTRON SPECTRUM

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Laser pulses can be tailored in the optimal control framework to achieve a desired effect in the system of interest. Several different systems have been studied ranging from atoms and molecules to nanostructures with applications from molecular bond breaking to qubits [1]. The optimized driving lasers have usually been constrained by some maximum frequency and either by the maximum peak intensity or fluence. However, experimental synthesis of tailored pulses is usually done by mixing a few different spectral bands [2].

Here we propose an optimization scheme [3] to produce experimentally realizable laser pulses. We take up to three component pulses each with a certain (possibly overlapping) spectral shape. The components are combined by optimizing their amplitudes, CEP, and time-delays. In addition, we constrain the peak amplitude and fluence of the total pulse.

As a demonstration, we optimize the photoelectron emission from atoms within the one-dimensional hydrogen model. The preliminary results (see Fig. 1) achieve a major cutoff extension and yield enhancement. Interestingly, the optimal driving laser does not have the highest allowed fluence; the exact shape of the pulse is important. These results will be supplemented by semiclassical simulations to explain the mechanisms behind the successful optimization.

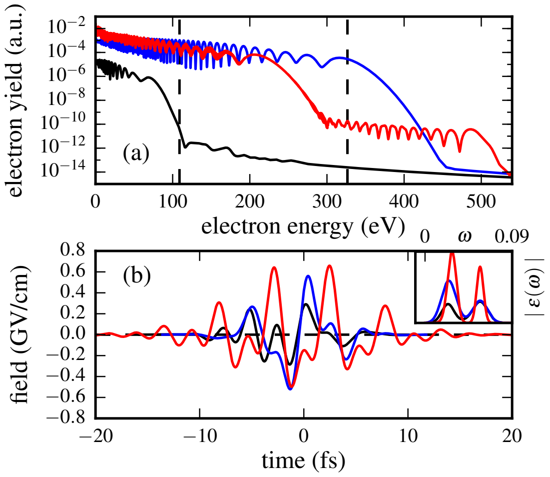

Fig. 1: Photoelectron spectra (a) and the corresponding laser pulses (b) and their spectral shape (inset of b) for the initial (black) and optimized pulses (blue and red).

Our optimization code can use any existing software for the time propagation and for the physical quantities to be optimized. In the future, this will make it easy to extend to three-dimensional and many-electron models, and to other targets such as the high-harmonic generation or selective bond-breaking in molecules.

[1] See, e.g, C. Brig et al., New J. Phys. **12**, 075008 (2010)
[2] A. Wirth et al., Science **334**, 195 (2011) and H. Fattahi et al., Optica **1**, 45 (2014)
[3] J. Solanpää et al., in preparation (2016).