Control of attosecond entanglement and coherence

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Attosecond science is a branch of ultrafast laser physics that aims to investigate and possibly control electronic motion on its natural timescale by means of pump-probe experiments. Attosecond pulses formed by the process of high-harmonic generation have wavelengths in the extreme ultra-violet (XUV) to soft X-ray spectral range. Accordingly, attosecond pulses are ionizing radiation for any medium (solid, liquid or gaseous) that is placed in its path.

Photoionization splits a quantum system under investigation into an ion and a photoelectron. The ion and photoelectron will commonly display quantum-mechanical entanglement, which influences the coherence that attosecond pump-probe experiments rely on. In my talk I will discuss experimental and numerical work demonstrating the role of ion-photoelectron entanglement in attosecond pump-probe experiments, by taking as an example the vibrational and electronic wavepacket dynamics that is induced in H_2^+ cations upon ionization of H_2 by an attosecond laser pulse [1-4]

I will show how tailoring the properties of the attosecond pulses (i.e. forming a pair of these pulses, or chirping these pulses) can be used to control the degree of ion-photoelectron entanglement that occurs, as indicated by the degree of vibrational, respectively electronic coherence that can be observed in the ion. In the calculations, the conclusions are furthermore supported by evaluation of the purity and a Schmidt decomposition of the ion + photoelectron wavefunction that results from the ionization process.

References

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