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Ultrashort pulses with (ultra)short wavelengths: novel schemes for few-femtosecond/attosecond pulse generation in the ultraviolet to soft X-Ray region

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In the attosecond molecular dynamics community, there is great interest in the development of light sources capable of producing tunable ultraviolet (UV) pulses with few femtoseconds duration. Indeed, the ability to excite resonantly (usually in the UV range) allows one to study the electronic processes of molecules in their neutral state, i.e., without ionizing it. Big strides in this direction have been made recently thanks to the resonant dispersive wave emission technique[1]. This technique however yields pulse energies lower than 1 μJ (after removing the fundamental), which could be limiting in experiments, especially after considering transport losses to the target.
In this talk we will present a novel scheme[2], based on cross-phase modulation in a gas-filled hollow-core fiber, that allows the generation of self-compressing, tunable, few-fs pulses in the UV, with energies >10 μJ.
In attosecond experiments, the data quality is often also limited by the poor photon flux of soft XRay attosecond probe pulses. This is attributable to multiple factors including the low single atom efficiency of the high-harmonic generation process, the difficulty in optimizing phase-matching and the limited spectral tunability of attosecond pulses.
We will discuss recent progresses in efficient attosecond pulse generation and in spectral tunability, achieved through the use of a parametric waveform synthesizer[3] based on the coherent synthesis of different pulses obtained via optical parametric amplifiers.

[1] Travers, J.C., Grigorova, T.F., Brahms, C. et al. High-energy pulse self-compression and ultraviolet generation
through soliton dynamics in hollow capillary fibres. Nat. Photonics 13, 547–554 (2019).
[2] Jiang, Y., Messerschmidt, J.P., Scheiba, F., Tyulnev, I., Wang, L., Wei, Z., and Rossi, G.M., Ultraviolet pulse compression via cross-phase modulation in a hollow-core fiber. Optica 11, 291-296 (2024).
[3] Rossi, G.M., Mainz, R.E., Yang, Y. et al. Sub-cycle millijoule-level parametric waveform synthesizer for attosecond
science. Nat. Photonics 14, 629–635 (2020).

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