High harmonic generation and free electron lasers: two sources of femtosecond XUV radiation for user experiments

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In the last 20 years two very different sources of femtosecond XUV radiation have open exciting new possibilities for experiments in physics, chemistry and biology, the free electron lasers and the high harmonic generation. These sources provided a huge step forward in the achievable light intensity and time resolution.
Free electron lasers are based on synchrotron radiation driven by electron linear accelerators. The achievable pulse energies of several millijoule and pulse durations of sub 100 fs enable multi photon processes in the XUV spectral range [1].
The high harmonic generation process on the other hand is driven by intense femtosecond lasers in the near infrared. The achievable pulse energies are typically a few nanojoule but the spectral bandwidth can reach several 10 eV, what enables pulse durations below 1 fs. This opened the field of attosecond physics, where electron dynamics are investigated in real time [2].
The pulse parameters of these two different sources are complementary in many respects. I will discuss the recent achievements on both sources, show prospects to reduce the pulse duration of free electron lasers to the sub femtosecond regime [3] and to enhance the pulse energy of high harmonic generation sources to the microjoule level [4].

[1] C. Pellegrini, A. Marinelli, and S. Reiche, Rev. Mod. Phys. **88**, 015006 (2016)
[2] P. B. Corkum and Ferenc Krausz, Nature Physics **3**, 381–387 (2007)
[3] Serkez et al., Journal of Optics **20**, 024005 (2018)
[4] Nayak et al, arXiv:1806.05485 [physics.atom-ph] (2018)