Séminaire LIONS

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Ultrafast nanoscale imaging using high order harmonic generation

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Ultrafast coherent diffraction using soft and hard X-rays is actually revolutionizing imaging science thanks to new sources recently available. This powerful technique extends standard X-ray diffraction towards imaging of non-crystalline objects and leads actually to a strong impact in physics, chemistry and biology. New ultrashort pulses recently available hold the promise of watching matter evolving with unprecedented space and time resolution. Femtosecond coherent and intense radiation in the soft X-ray (λ = 10-40 nm) is currently produced in our laboratory, from highly non linear frequency conversion (high harmonic generation). A high intensity UV-X coherent beam is obtained using a loose focusing geometry, which allows coupling a very high amount of Ti:Sapphire laser system energy in the HHG process. Using a long gas cell and a long focal length lens, the emitting volume can be increased by orders of magnitude compared to standard HHG set-ups. This approach, allows reaching up to $1x10^{11}$ photons per shot for the 25^{th} harmonic (λ=32nm).

We have recently taken up the challenge of ultrafast coherent imaging of nanometric objects, such as nano-particles using our table-top soft X-ray source. We have very recently demonstrated nanoscale imaging in a single shot mode reaching 70 nm spatial resolution and 20 femtoseconds snapshot [1]. We then implemented a recently proposed holographic technique using extended references. This technique, easy to implement, allows a direct non iterative image reconstruction. In the single shot regime, we demonstrated a spatial resolution of 110nm [2].

This opens fascinating perspectives in imaging dynamical phenomena to be spread over a large scientific community. We will briefly present recent results in the investigation of femtosecond phase spin-reversals of magnetic nano-domains or ultrasfast molecular rearrangements.

[1] X. Ge et al., Optics Express **21**, 11441 (2013)
[2] D. Gauthier et al., Physical Review Letters **105,** 093901 (2010).