Short-wavelength Photon-in/Photon-out with a "Home Lab" Source: Limits & Potentials

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There is a number of frontier applications in materials science and technology, and their progress depends on advanced *analytical* technologies. Advanced techniques, e.g pump-probe and X-ray absorption spectroscopies, permit to probe ultrafast time scales in the femto- or even attosecond, or ultrasmall length scales down to a few nanometers of chemical states. Such techniques, established at accelerator light sources, e.g. XFEL, are profiting from the remarkable progress in light source technology. Fourth generation light-sources offer now unprecedented inspection capabilities, permitting detailed insights in the ultra-fast and ultra-small, at and beyond the sample destruction limit.

On the flip-side, two major drawbacks are to be considered: (i) a ultrashort XFEL pulse is by definition associated with a broadband signal, i.e. poor spectral resolution of as high as a few eV's; (ii) the facilities are so expensive that can be operated only on a short beam-time basis. The related limited access makes these advanced sources uniquely dedicated to *proof-of-principle* research. This means that *high-risk* research, *industrial* R&D, and mere young scientists' *training* are a few examples of "no- go activities" at accelerator light sources. In a symbiotic approach, these large-scale sources will thus require complementary tabletop systems for preparing the beam-time and for performing "beyond the proof-of-principle" activities. Furthermore, material science applications, e.g. catalysis, photovoltaics, batteries, etc., are mainly on the "slow and large end", which is in principle possible at "home lab" sources.

In this presentation a review of the state-of-the-art of "home lab" sources is given, along with a discussion on the specific alternative methodologies to overcome intrinsic limitations, e.g. lack of tunability. For instance, "*high energy resolution off-resonant spectroscopy*" (HEROS) [1,2], is promising for single-shot tuning-free X-ray absorption spectroscopy being investigated.

References

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