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The physics of laser-based coherent x-ray generation– attosecond science meets nonlinear optics meets nanotechnology

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The generation of coherent soft x-ray light through high-order harmonic upconversion of fentosecond laser pulses has proven to be a topic of sustained and increasing interest, by virtual of the fact that it relates a relatively new regime of AMO physics to the prospect of broad application in science and technology. In the high harmonic generation (HHG) process, intense laser light interacting with an atom or molecule results in coherent light emission in the EUV and x-ray regions of the spectrum through the rescattering process. The basic physics of the emission process was understood relatively quickly after its experimental observation; more challenging has been understanding how to best take advantage of HHG as a nonlinear optical process where not-only is the nonlinear response of the conversion medium nonperturbative, but it is non-instantaneous, and the medium is strongly absorbing, dispersive, and dynamically changing. Remarkably, despite these issues the HHG process allows us for the first time to implement lab-scale "x-ray laser" sources that have broad application. In this talk I will present an overview of the nonlinear optics of HHG. I will also discuss some of the science that can be done with this source, in areas ranging from AMO science to nanoscale imaging and materials physics.

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