Quantum optics with X-rays: Dynamical control of resonant interaction

Olga Kocharovskaya

Department of Physics and Astronomy, Texas A&M University, TX:77843-4242, College Station,USA

Recently a new, rapidly expanding field of research, X-ray quantum optics, has been formed due to the development of the coherent X-ray sources, including X-ray plasma based lasers, high harmonic generation sources and X-ray Free Electron Lasers (XFEL). We discuss how to control the spectral/temporal characteristics of an X-ray radiation produced by these sources via variation in time/space of the parameters of its resonant interaction with a medium (atomic or nuclear transitions in gases, plasmas or solids) driven by a sufficiently strong optical or IR laser field. Several applications of this technique are considered, including (i) control of single X-ray photon waveform and realization of quantum interfaces between single photons and nuclear ensembles, (ii) generation of intense attosecond pulses in the "water window" range (promising for dynamical microscopy and imaging of material and biological nano-structures, including proteins in living cells), (iii) spectral enhancement of XFEL radiation (promising for development of long-lived quantum nuclear memory, ultrahigh resolution nuclear spectroscopy, and nuclear frequency standards).