ABSTRACT

Characterization of statistical properties of X-Ray FEL radiation by means of few-photon processes

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The pulsed radiation from a free-electron laser (FRL) in the self-amplified spontaneous emission mode changes its time-dependent electric field from shot to shot in a completely chaotic fashion. For experiments in the x-ray regime with data acquisition over several FEL pulses, the characterization of the statistical properties of the radiation is essential, i.e. spectral or time correlation functions of the electrical field have to be determined. By treating the matter-field interaction perturbatively within a quantum electrodynamic framework, we determine the relevant correlation functions for one- and two-photon processes, i.e. for single and double photon absorption and elastic scattering. The radiation field is described by a general multi-mode density matrix. The possibility of utilizing two-photon-induced double ionization to determine the second-order spectral correlation function of the radiation field is discussed. A feasibility study is performed for helium and neon. Using the radiation parameters expected for the Linac Coherent Light Source currently under construction at the Stanford Linear Accelerator Center, ion count rates are determined in dependence of intensity and other pulse properties.

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