

Soft X-ray generation in the field of mid-infrared ultrashort laser pulses

Powerful mid-infrared ultrashort laser pulses provide unique opportunities for spectral-temporal transformation of electromagnetic radiation which are unavailable in visible and near-infrared ranges. It is most clearly apparent in the High Harmonic Generation (HHG) owing to the fact that harmonics' cut-off frequency is directly proportional to the third degree of pump wavelength. Using the features of phase-matching, it was experimentally and theoretically showed that this process makes it possible to efficiently generate X-ray with photons energies of keV and up.

Methods increasing efficiency of HHG from pump femtosecond mid-infrared pulses were theoretically analysed in this paper. Slowly Varying Amplitude approximation was used both for describing spectral-temporal transformation of pump pulse in gas and considering HHG. Transit dipole moment, which is the source of high harmonics, were derived from Corkum-Lewenstein model for atom with single active electron.

It was found regimes, when reparation of positive phase addition of neutral atoms by negative addition from free electrons allows to make phase-matching for X-ray high harmonics with energy which are sufficient to be a seed for Free Electron Lasers.