CHARACTERISTICS OF NONLINEAR THOMSON SCATTERING IN THE REGIME OF TIGHT LASER PULSE FOCUSING

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One of the new scheme of bright attosecond X-ray pulse generation is based on nonlinear Thomson scattering (NTS) of a laser pulse by free electrons or colliding particle beams. In most studies NTS was investigated with plane wave approximation and/or paraxial approximation for the laser pulse. Development of NTS theoretical model is certainly important for understanding of tight focus regime practicability; when the focal spot diameter, *DF*, is comparable to the laser wavelength *λ.* Such X-ray pulses have many applications in atomic and molecular physics, chemistry, and also in life science [1].

In this work we investigate NTS characteristics for a tightly focused laser pulse scattered by electrons placed in the vicinity of the laser focus. The description of the laser field is made by accurate angular-spectral solution of Helmholtz equation [2] or Stratton-Chu integrals [3]. The calculations of secondary emission characteristics, such as an angular spectrum and an angular power, are made with electron trajectories that were calculated by numerical integration of the test particles relativistic motion equation. In our calculations we considered 35 fs, 150 TW laser pulse with relativistic intensity and different value of the focal spot diameter *DF* = *λ* .15*λ,* where *λ* = 800 nm.

The calculation of angular-spectral characteristics have shown that for moderately focused laser pulse secondary radiation consists of attosecond pulse train; its number is determined by the laser pulse duration. The focal spot diameter decrease and corresponding the focal intensity increase lead to the reduction of attosecond pulse number in the train. At the same time the emission power peak and the photon energy, corresponding to the maximum of spectral function, continue to grow reaching a maximum at DF = 9 λ.Thus, the effect of secondary radiation energy increase by laser pulse focusing has a limit, which is associated with a decrease of interaction area of the laser radiation and electrons. It is worth noting that in the case of extremely tight focusing the single attosecond pulse generation is possible. Radiation characteristics depend quite strongly on the initial phase of the laser pulse and require averaging phase especially within the limits of tight focus.

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References

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