Generation of Fast Electrons and High-Energy Photons in Ionization of Heavy Atoms by Laser Beams of Extreme Intensity

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Ongoing progress in the development of the new generation of multi-petawatt (PW) femtosecond laser sources opens the way to laboratory studies of the interactions of electromagnetic fields with atoms, electrons, and plasmas at intensities 10^{22} W/cm^2 and higher. The probabilities of nonlinear phenomena of classical and quantum electrodynamics are essentially determined by the distribution of the laser field in space and time. In tightly focused pulses, the field configuration significantly differs from that of a plane electromagnetic wave; thus, *in situ* diagnostics of multi-PW laser beams focused to achieve extreme intensities are of key significance for upcoming experiments [1-3]. One of the methods considered for such diagnostics is based on the observation of tunnel ionization of heavy atoms and production of highly charged ions [1,4] in the focus of a PW laser beam. This process is followed by the acceleration of photoelectrons and the emission of high-energy photons during the electron escape from the focal area.

In this talk, we present results of Monte Carlo modeling of the ionization dynamics for $3\cdot10^4$ Ar atoms in the field of a femtosecond pulse with characteristics corresponding to those currently available at the Aplollon facility operating in France [5]. Considering the intensity interval $10^{21}-10^{23}$W/cm^2, we calculate photoelectron and photon spectra and angular distributions, which, along with the charge distribution of the ions, carry significant information both on the peak laser intensity and on its distribution inside the focus.

The photoelectron spectrum appears predominantly formed by a strong longitudinal acceleration, with a width dependent on the peak laser intensity and the highest ionization potential of the atomic species. At the same time, it demonstrates some distinguishable features reflecting the focal spot size. The spectral-angular distribution of radiation is concentrated in a narrow cone with an angle determined by the peak intensity. However, such ionization-induced radiation appears strongly suppressed by the co-propagating motion of the laser pulse and photoelectrons. A relatively weak counter-propagating probe pulse of intensity $\simeq 10^{18}$W/cm^2 was used to enhance the signal through nonlinear Thomson backscattering [6].

Some results presented in this contribution have been recently published in [7].

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