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Ionization and Radiation properties of plasma created by ultra-intense femtosecond laser pulses interaction with medium- and high-Z foils

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Study of radiation properties of solid dense plasma irradiated by ultra-intense lasers has a great interest both from fundamental physics and different application point of views. Presently, the advances in many high-technology fields depend on the availability of accurate atomic data — information on the fundamental properties of electronic structure of atomic systems and related elementary processes. The reason is that those properties are responsible for the interactions of matter with electromagnetic radiation and charged-particle beams, being of primary importance for many practical implementations. The relevant data form the basis for upgrading high-resolution diagnostic tools in the studies of high-energy-density physics and astrophysics as well as for the development of ultra-bright tabletop sources of x-ray and extreme-ultraviolet radiation and laser-driven particle accelerators. That is especially true for plasmas produced by high-intensity femtosecond laser pulses.

Obtaining of systematic atomic data and understanding of ionization processes in specific to such plasmas conditions will allowed to find more effective ways of plasma excitation that would enable to increase the x-ray energy yield in the spectral range of interest, to increase the energy of accelerated particles and further reduce the requirements to ultrashort-pulse laser driver energy and, therefore, its cost and size.

The recently upgraded the petawatt-class JKAREN-P laser (KPSI, QST) allows to deliver to the target pulses with intensity of ~10^{22} W/cm^2 within a micron size focal spot and 35 fs laser pulse duration. So a huge energy is deposited to micrometer volume of the matter for the short time. We will present results on investigation of ionization and parameters of plasma generated under interaction of such laser pulses with medium - (Al) and high - Z (Ti, Fe, Ag , Au) thin foils by means of x-ray high resolution spectroscopic method.

The strongly non-linear grow of x-ray yield on dependence of laser intensity was spectrally observed [1]. Parameters of plasma have been characterized from both front and rare side of targets. Experiments have been carried out at variety laser condition and showed that degree of ionization and x-ray emissivity of plasma drastically decrease with displacement of target from best focus position and with decrease of laser contrast [2, 3]. The 2D PIC code simulations of femtosecond laser interaction with various materials were provided and compared with experimental results. It was also show, that appearance of unique spectral lines corresponding to emission from hollow atoms gives evidence of approaching plasma condition to so called radiation dominated kinetic regime (RDKR) [4].

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