Ultraintense X-Ray Radiation Generated by Relativistic Laser Plasma in the Radiation-Dominated Kinetic Regime and its using for Exotic Dense –matter States Pumping

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Abstracts: *The study of high energy-density matter motivates the development of powerful X-ray sources that can produce and probe exotic matter states with high densities and multiple inner-shell electronic excitations. Here, we present overview of our recent results, which via high-resolution X-ray spectroscopic measurements and kinetic simulations demonstrate that the energy of femtosecond laser pulses with relativistic intensity approaching to ~ 10^{21} W/cm^2 is efficiently converted to X-ray radiation emitted by "hot" electron component in collision-less processes and produced exotic states in solid density plasma periphery. Our results promote ultra - relativistic laser-produced plasma as unique ultra-bright X-ray sources that can reach already today intensities above 10^{17} W/cm^2 for studies of matter in extreme conditions as well as for radiography of biological systems and for material science studies.*

The radiation properties of high energy density plasma are under increasing scrutiny in recent years due to their importance to our understanding of stellar interiors, the cores of giant planets, and the properties of hot plasma in inertial confinement fusion devices. Recently, it was demonstrated[1-5] that conventional optical lasers with pulse duration of 40 – 1000 fs and laser intensity (0.3-1.0)x10^{21} W/cm^2 irradiating Al foils could generate very bright X-ray radiation with intensities exceeded 10^{17} W/cm^2 and efficiently produce exotic states of matter (so called Hollow ions), which are very far from equilibrium. Here we give overview of obtained results and present new set of measurements of high spectrally resolved K-shell emission of Si foils irradiated by sub picosecond laser pulses of Vulcan laser facility. Our investigations asserts that exotic Hollow ions states can be accessed and probed not only by X-ray radiation of XFEL lasers, but also upon using optical laser technology. In the latter case the generated X-ray radiation is polychromatic with its energy and intensity comparable or even exceeding that of current XFELs and complements the recent observations of such exotic states using XFELs. The results reported here suggest that radiation dominated atomic physics processes could be efficiently studied at high optical laser intensities.

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