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Recent progress of laser-driven intense X-ray sources and the appilcations

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Short pulse x-ray sources become indispensable diagnostic tools in modern science and technology and are widely used in probing substances for new material development, protein crystallography in innovative drug development, and non-destructive x-ray imaging etc. Laser-driven x-ray source is one of the promising x-ray sources and has potentials of downsizing and of ultra-short duration toward atto-second region. These features expand the possibility of laser-driven x-rays in an industrial and scientific use, and it is already proved partially as EUV source for the lithography and as ultra-short pump and probe tools.
The progress of laser-driven x-rays has been along with the progress of high power laser technology. In this sense, recent advent of high power laser is quite interesting. Now we have reached the intensity peak of 1021 W/cm2 on target to produce plasmas, in which the electrons are collectively quivered with relativistic velocity by the laser electric field. This new type of plasma, we call it as relativistic plasma, makes it possible for us to investigate new schemes of x-ray generation.
In this presentation, in addition to some conventional short pulse x-ray sources and the applications, several examples of research activity of the x-ray source development using the relativistic plasma are introduced. The first highlight is higher-order harmonics from relativistic plasmas [1]. In this scheme, localized electron density peaks formed by the laser-plasma interaction are strongly oscillated by laser electric field and emit the x-rays. The 2nd is Thomson back scattering [2] in which laser-accelerated electrons collides with another optical pulse. The 3rd is gamma-ray flash [3] originated from the radiation damping effect in the interaction between the ultra-intense laser field and plasma.
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