X-ray generation from laser-produced plasmas for use in plasma diagnostics and applications

Hiroaki Nishimura
Institute of Laser Engineering, Osaka University
nishimu@ile.osaka-u.ac.jp

Invention of laser and subsequent implementation of a new laser technology such as Q-switch oscillation, mode-locking, and chirped pulse amplification to the laser system, shorter duration and higher power laser pulses became available. As a consequence, one can generate intense radiation pulses ranging from Tera-Hertz wave (~100 μm in wavelength), visible light, extreme ultraviolet light (EUV, ~10 nm), x rays (0.1-1 nm), to γ rays (<<0.1 nm). Dominant photon energy is determined by laser-irradiation conditions and choice of target materials. For example, conversion efficiency, defined by the ratio of the x-ray radiation emitted in whole space to laser energy onto the target, can be as high as 80% when a target consisting of high Z materials such as gold is irradiated with frequency-tripled Nd:glass laser light at 10^{13} W/cm^2. Such high conversion enables us to drive a fusion pellet for high fusion gain. Intense radiation pulse is also useful to observe dynamics of hot dense material such as laser-driven fusion pellet, alive creatures, transient phenomena of shock compressed crystalline matters, and non destructive inspections. LPP radiation is rather easy to handle compact pulse source, therefore extending to industrial applications.

In this lecture, principles of x-ray generation in laser-produced-plasma (LPP) are overviewed, followed by various applications of LPP x-rays for plasma diagnostics and industrial applications.

The lecture consists of the following sections:

1. **Principles of laser plasma x rays**
2. **X-ray generation with low-density materials and application to HEDP experiments**
3. **X-ray generation in an x-ray confining cavity (Hohlraum) and application to IFE**
4. **Kα line emission and applications to plasma diagnostics**
5. **Extreme Ultraviolet (EUV) light generation and application to industry**
6. **Summary**