Induced Compton Scattering off Anisotropic Radiation

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Abstract

Induced Compton scattering (ICS) is an interaction between intense electromagnetic radiation and diffuse plasma. ICS is important when a brightness temperature of the radiation being larger than the rest-mass energy of an electron and also the density of the plasma being smaller than the critical density. In our past study [1], we deduced an equation that expresses a non-linear spectral evolution of the radiation spectrum by ICS on the assumption of the isotropy of the system. We found that the scattered photons rapidly lose their energy by ICS with continuously forming solitary structures in frequency space (see Figure 1). The characteristic solitary structures, which have the logarithmic width characterized by an electron temperature, have never been observed both in laboratories and space.

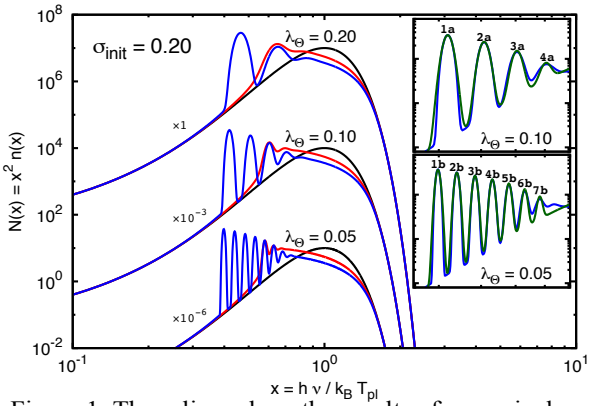

Figure 1. Three lines show the results of numerical calculations for spectral evolution by ICS [1], where the black lines are the initial spectra and blue lines are the final spectra. The temperature is larger for the upper curves. The solitary structures of blue curves have logarithmically width characterized by the electron temperature (T_{pl}).

Here, we extend the equation to the case for anisotropic radiation since such a intense radiation is highly directional in nature. We focus on the spectral evolution of scattered radiation because, in some situations, ICS does not simply isotropize the radiation. We find that the spectrum of the scattered radiation forms the solitary structure of logarithmic width that is characterized by both the electron temperature and the opening angle of the initial radiation. Figure 2 is the result of the calculation. Applying to a laser device whose energy of 3.3J, wavelength of 800nm, band-width of 36nm (duration of 33fs) and beam waist of 4.3um, we calculate the spectral evolution of scattered radiation by the plasma whose temperature of 1keV and density of 10^{18}cc^{-1}. The ICS signature would be observed for some present laser devises.

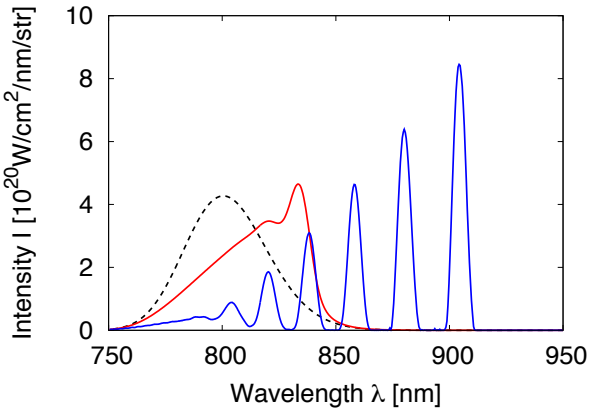

Figure 2. Spectral evolution for anisotropic radiation. The black line is the initial spectrum and the blue line is the final spectrum.

References

[1] Tanaka, Asano, & Terasawa, Prog. Exp. Theor. Phys. 2015, 073E01