Statistical investigation of magnetic and temperature properties of white-light flares

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White-light flare is a phenomenon in which has enhancement of visible continuum in a solar flare, and is mainly associated with a large flare. Although the emission mechanism of white-light flares has not been well understood yet, previous studies have suggested that their origin is accelerated non-thermal electrons and that a relatively strong magnetic field exists in the acceleration site (e.g. Watanabe et al., 2017).

So, we tried to estimate the coronal magnetic field strength by using the turn-over frequency of gyro-synchrotron emission in microwaves (Dulk 1985). We used the Nobeyama Radio Polarimeters (NoRP) for >M3 class flares during the period from January 2011 to December 2017. We found 29 events which were simultaneously observed with white-light (SDO/HMI continuum) and microwave (NoRP) which had loop-top microwave source in the image observed with Nobeyama Radioheliograph. However, we couldn't find any difference in turn-over frequencies with or without white-light emission. In order to investigate the relationship between white-light emission and coronal magnetic field, this method might be too simple because the turn-over frequency is determined by not only the magnetic field strength but also the electron density and so on (Dulk 1985).

To overcome this problem, next, we tried to compare field strength and temperature of white-light emission region. The former/latter can be derived from SDO/HMI magnetogram/three continuum bands of Hinode/SOT. We performed a statistical analysis for 35 Hinode white-light events and then found the field strength of white-light emission region were correlated with the maximum brightness of the white-light emission. Assuming that the magnetic field strength at the acceleration site in the corona is somehow proportional to the photospheric magnetic field strength at the white-light emitting region, this result suggested the strong acceleration process which produces WLFs takes place at the strong magnetic field region in the corona. Moreover, we also found that the amount of the white-light enhancement was approximately proportional to the fourth power of the radiation temperature. From this result, it is considered that the white-light enhancement is black body radiation. From the above results, it is considered that in the white-light flare, large number of electrons accelerated by strong magnetic fields penetrate to the foot-points near the photosphere, and as a result, black body radiation emits as white-light emission at the heated region.

Keywords: Sun: flares, Sun: radio radiation, Sun: magnetic fields

