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「ひので」による白色光フレア観測
White-Light Flare Observations by Hinode/SOT

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In association with solar flares, we sometimes observe enhancements of visible continuum radiation, which is known as a ”white-light flare”. These flares are mainly associated with energetic events, such as X-class flares, and they are still only rarely observed since first being discovered more than 150 years ago. Because many observed events show a close correlation between the time profiles and locations of white-light emission, and the hard X-rays and/or radio emission, there is some consensus that the origin of white-light emission is due to accelerated particles, especially non-thermal electrons. During big flares which show white-light emission, huge amounts of electrons are accelerated to high energies ? there might also be huge amounts of protons and ions accelerated to high energies. These large amounts of high energy particles are released into interplanetary space as Solar Energetic Particles (SEPs) and sometimes they reach very near the Earth, and also affect the Earth’s environment.

Hinode/SOT has the capability of observing white-light flares in the G-band and continuum (Blue, Green, Red) with a broadband filter. Using the Hinode Flare Catalogue (Watanabe et al., 2012), we searched for white-light events using G-band and continuum data. We found more than 20 Hinode/SOT white-light events in association with M-class or larger flares between launch (September 2006) and December 2012. We compared the white-light emission data with hard X-ray emission data and/or the strength of the photospheric magnetic fields and looked for any relationship between them.

First, we analyze one of the white-light flares that occurred on December 14, 2006 in detail. We use G-band data from SOT for white light emission and hard X-ray data observed by the RHESSI satellite. We compared the white-light power and the electron power assuming a blackbody for the white light and the thick-target model for the non-thermal electrons, obtaining a good correlation (Watanabe et al., 2010).

However, this is hard to understand in terms of the expected respective emission heights. Theoretically, white-light emission is generated near the photosphere, but non-thermal electrons of energy ˜50-100 keV should deposit their energy in the lower chromosphere, more than 500 km above the photosphere.

We investigate this problem with observations of the near-limb X1.7 flare of 27 January 2012, using three continuum bands of the Hinode/SOT. The near-limb location allows us to determine the heights of the emissions. We found the white-light emissions to be located low down, apparently at the photosphere, with the Ca II H emission originating from higher up. We also calculated the temperature distribution from the three white-light continuum bands. The white-light emission temperature is calculated to be about 5500K, and we found that the lower layer has a higher temperature. These findings suggest that high energy particles penetrate to near the photosphere, heating the ambient atmosphere from very low (near photospheric) layers.

In this paper, we present some of the Hinode/SOT white-light events and discuss the flare parameters and origin of the white-light emission.

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