Observations of high-energy particles in solar active phenomena

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Active phenomena in the solar corona affect the terrestrial environment. In addition to 'Variation of the solar radiation', and 'supply and disturbance of interplanetary magnetic field', 'high-energy particles produced in the solar corona' is important for the space weather research.

The particle acceleration in the solar corona is one of fundamental research topics in physics. Also, it is one of important topics in the space weather research related with the environment of satellites and astronauts. The particle acceleration is mainly caused by solar flares and CMEs. Focusing this presentation on the former, the recent results obtained from hard X-ray, gamma-ray, and microwave observations, are briefly reviewed.

From 1991 to 2001, thousands of solar flares have been observed with the hard X-ray telescope (HXT) on board the Yohkoh satellite. A lot of new results were accomplished through HXT observations. It is found in solar flares that three kinds of hard X-ray sources exist, and their respective characteristics are clearly revealed with spatially-resolved observations. They are so-called, 'footpoint source', 'looptop impulsive source (above-the-looptop source)', and 'looptop gradual source'. Also, collaborating with the soft X-ray telescope on board Yohkoh, HXT confirmed a solar flare model based on magnetic reconnection. However, there remain still many problems on particle acceleration, including acceleration mechanism, though we have partially obtained the information on the acceleration site and the pitch angle distribution of accelerated electrons.

The RHESSI (Reuven Ramaty High Energy Solar Spectroscopic Imager) satellite was launched in 2002. RHESSI observes solar flares in hard X-rays and gamma-rays with a higher capability than Yohkoh/HXT. Although there is few results from imaging-spectroscopy analyses, several new results were obtained from spectral observations with a high energy resolution and from imaging observations in gamma-rays. As to the former, the energy-budget is studied from accurate spectral fitting in hard X-ray energy range and the information on ion acceleration is derived from gamma-ray line fitting. The latter is the largest advantage of RHESSI. However, the number of events, which are available for gamma-ray imaging analysis, is very small. Only an X-class flare, occurring on 23 July 2002, was analyzed in detail.