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太陽フレアの硬 X 線・ガンマ線観測
Hard X-ray and Gamma-ray observations of solar flares

石川 真之介 [1*]
ISHIKAWA, Shin-nosuke[1*]

[1] カリフォルニア大学バークレー校
[1]University of California, Berkeley

Most of the high-energy particles in the solar system are accelerated in the Sun, and these particles affect space and terrestrial environments. The detailed properties of the energy release processes in solar flares, as well as the mechanisms that accelerates particles, are currently not well understood. Accelerated electrons and ions emit hard X-rays (HXRs) and gamma-rays, therefore HXR and gamma-ray observations provide important information about the energy release process in solar flares. HXR imaging observations reveal the spatial structure of particle acceleration in solar flares, including where flare-accelerated energetic electrons are stopped by the high density of the chromosphere (flare footpoints) and where flare-heated plasmas fill magnetic loops. Thermal SXRs represent magnetic flare loops filled with thermal plasma. In addition to footpoints, a coronal HXR source above the flare loop top was observed by the hard X-ray telescope (HXT) onboard the Yohkoh satellite (operated in 1991-2001). This event is well known as the Masuda flare. This above-the-loop-top source suggests that the origin of solar flares is magnetic reconnection.

In 2002, the RHESSI satellite, providing imaging spectroscopy from 3 keV up to 10 MeV, started to observe solar flares. Simultaneous wide-range HXR imaging and spectroscopy of solar flares can be done for the first time by RHESSI. RHESSI observed solar flares down to the scale of microflares, and the presence of HXRs from accelerated electrons in microflares is shown. In addition, RHESSI observed many coronal HXR sources so far, and their spatial and spectroscopic features are investigated. RHESSI's imaging spectroscopy capability allows us to study the timing and energetics of the above-the-loop-top source relative to the footpoints with much better accuracy than before. In the currently best example of a RHESSI flare that resembles the Masuda flare geometry, the above-the-loop-top source is observed to peak ?10 s earlier than the footpoint sources and decays afterwards while the footpoint source stays bright. This suggests that the above-the-loop-top source provides the precipitating electrons that feed the footpoint source.

To improve the dynamic range for future observations, grazing-incidence HXR focusing optics are a promising new technology for future solar observations. A new sounding rocket mission, the Focusing Optics X-ray Solar Imager (FOXSI, to be launched in March, 2012), will test out grazing-incidence HXR focusing optics combined with position-sensitive focal plane detectors for solar observations. FOXSI will show the presence and energy content of accelerated electrons in the quiescent region nanoflares.

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