Comparison of the Optical Characteristics for Japanese Space Solar Telescopes: Hinode/XRT and Yohkoh/SXT

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Two Japanese Space Solar Telescopes, the Yohkoh Soft X-ray Telescope (SXT) and the Hinode X-Ray Telescope (XRT) have made great contributions for more than three decades to our research on three dimensional structures of coronal magnetic field. Aside from morphological studies, one of the main purposes of these instruments is to study the spatial and temporal variation of physical quantities of coronal plasma and interpret the mechanism of coronal activities. Both are so-called Wolter-type grazing incidence (GI) mirror telescopes with high resolution CCD cameras as a recording device. Astronomical telescopes are generally designed so that the quality of focusing reaches its best at or very close to the optical axis, and inevitably the optical performance becomes worse as it goes away from the center. However, the Sun is a large object about half degree in diameter almost fully filling in the field of view of these telescopes, and thus the targets near the limb of solar disk are usually placed in the off-axis region of full-disk synoptic images. For this reason, the optical design of an X-ray solar telescope should take into account the uniformity of image quality over a wide FOV. Together with an effort in designing the optics of the instrument, the imaging artefacts shown in the off-axis region should be calibrated carefully in order for the observed data to be properly interpreted.

Our presentation will introduce the results of comparison of the optical characteristics of Hinode/XRT and Yohkoh/SXT, especially for the scattered lights and the effect of vignetting. We have analyzed highly saturated in-flight images during the solar flare to estimate the amount of scattered light inherent in the observed data. It is revealed that the light scattered due to the roughness of GI mirror surface has a power-law distribution and its amount depends on the energy considered, which allows us to complete a PSF profile from the core to the scattering wing. Vignetting is also one of the important optical properties of a telescope, as it directly describes its ability to collect photons at different locations and with different energies. We have evaluated the vignetting effect by analyzing the 2D distribution of effective area in the FOV taken from pre-launch experiments and found that the overall pattern of vignetting in two instruments are quite different from each other. Detailed results on the interesting optical characteristics will be introduced in our presentation.

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