Activity Report of the NAOJ Visiting Scholar Program

Host Project/Division: Solar Science Observatory Name of Host Scientist: Ryouhei Kano

Name of Visiting Scholar: Junho Shin

Title: Visiting Professor

Period: from 2018/04/06 to 2018/07/06

I. Report from the visiting scholar

[i] Achievement during the period of stay (in comparison with the initial plan)

(Collaborative Research)

"Characterizing the Variations of Key Plasma Properties in Coronal Holes over Two Consecutive Solar Cycles 23 and 24"

The ultimate aim of our multi-year study is to examine the variation of solar plasma properties in the coronal hole regions and the off-limb area for solar cycles 23 and 24 and to understand their relations with other physical phenomena. Plasma properties in and near the coronal hole regions should be examined from the analysis of Yohkoh/SXT and Hinode/XRT data covering almost two decades. The Sun is, however, a large astronomical object and thus targets near the limb of full-disk images are placed at the outskirt of the field of view. For this reason, the off-axis performance of the solar telescopes should be characterized very carefully in order for the data away from the center to be properly interpreted.

During the period of staying at NAOJ, we have first evaluated the vignetting effect of Hinode/XRT by analyzing the 2D distribution of effective area in the field of view taken from MSFC/XRCF pre-launch experiment. The values of effective area calculated from 25 PSF images in the FOV (on the CCD) enabled us to understand the XRT vignetting effect. Four data sets obtained for two different energy sources, Al-K line (1.49 keV; 8.3 A) and Cu-L line (0.93 keV; 13.3 A), have been used in our analysis. Especially, it was necessary to examine the degree of offset of the optical center prior to evaluating the vignetting effect of an astronomical telescope, which becomes possible to evaluate the asymmetry of XRT vignetting effect by examining the result of curve fitting at each column and row. It is revealed from our study that, unlike the case of Yohkoh/SXT, the degree of offset of an optical center is not serious and thus shows little deviation from rotational symmetry. We finally evaluated the XRT vignetting effect together with the location of vignetting center by fitting the mathematical form of function to the experimental data. A standard integral of hyperbolic tangent function has been applied for the fitting. Our results show that the vignetting varies very linearly from the center to the outskirt of FOV but their gradients are quite different from what was defined originally by the manufacturer. In particular, the energy dependence of vignetting pattern has been first found in our study, which is also different from what has been used so far for the calibration of XRT data. More detailed results on the Hinode/XRT

vignetting effect will soon be submitted to Astrophysical Journal and published probably early next year.

(Education)

It is afraid that I could not get an opportunity to give lectures to the Sokendai students this time. But instead I have eagerly joined for three months the scientific meetings and seminars of Solar Science Observatory group such as SSP and SXT seminars every week and had extensive discussions with students as well as professors about most recent issues of solar physics.

(Others)

[ii] Any comments on this program

I've no special comments on the program itself.

[iii] List of publications and presentations by the visiting scholar in collaboration with NAOJ staff or graduate students

Part of our results have been presented in the international conference named 'Hinode-12' held in Granada, Spain.

Date: 10-13 September, 2018

Title:
Determination of Large Scale Plasma Properties of Solar Corona Using the X-Ray Telescope Onboard Hinode: I. Off-Axis Calibration of Vignetting Effect

Presenter:
Junho Shin (School of Space Research, Kyung Hee University, Korea / Solar Science Observatory, NAOJ)
Takashi Sakurai (Solar Science Observatory, NAOJ)
Ryouhei Kano (Solar Science Observatory, NAOJ)

Important issues:
It should be emphasized that the vignetting of Hinode/XRT varies very linearly from the center to the outskirt of FOV but their gradients are quite different from what was originally given by the manufacturer. Especially, the energy dependence of vignetting pattern has been first found in our study, which is different from what has been used so far for the calibration of XRT data.

Responses from viewers:
During the conference, I had discussions with solar physicists about the details of our presentation. They all agreed that the method of correction for Hinode/XRT vignetting should be updated as soon as possible for a better calibration of observed data. Especially, I had intensive discussion with Dr. Aki Takeda of Montana State University and we concluded that the analysis of in-flight data is inevitable for calibrating the XRT data taken from different filters installed in the telescope. New Hinode Observing Plan (HOP) specially designed for four quadrant images will soon be prepared for our next study.

II. Report from the host scientist

[iv] Any comments on this program
I have no specific comment on this program. I am just very grateful that I could invite Prof. Shin using this program. We would like to continue the collaboration for achieving a conclusive result.

* If it is necessary, two extra pages can be used. The page limit of the entire document is five pages.

* This report will be posted on the website of the Research Coordination Committee, NAOJ except [v].

【Request】

After a year following the completion of the research, we will send you a request to submit a list of papers and other results that have been produced by this research collaboration. We appreciate your cooperation.