MedCrave
Step into the World of Research

Physics & Astronomy International Journal

The Yohkoh Legacy (Data) Archive

Abstract

The *Yohkoh* mission recorded the soft and hard x-ray properties of the sun for an entire sunspot cycle from 1991 through 2001. The *Yohkoh* Legacy Archive (YLA) has been created to house the reduced data, data products, and all relevant operational information of the mission. Some data products in the YLA, e.g., the full-disk x-ray movies of the corona, are intrinsically beautiful and will be of interest to anyone conversant in science and the cosmos. It is the purpose of this communication to introduce *Yohkoh* and the YLA to this broad community.

Keywords: *Yohkoh*; Solar; Corona; X-ray; Data; Archive; Spacecraft; Flare

Short Communication

Volume 1 Issue 3 - 2017

Loren W Acton*

Department of Physics, Montana State University, USA

***Corresponding author:** Loren W Acton, Department of Physics, Montana State University, P. O. Box 173840, Bozeman, MT, 59717-3840, USA Tel: 1+406+994+3614; Fax: 1+406+994+4452; Email: loren.acton@montana.edu

Received: September 28, 2017 | **Published:** October 11, 2017

Abbreviations: YLA: *Yohkoh* Legacy Archive; SXT: Soft X-ray Telescope; HXT: Hard X-ray Telescope; BCS: Bragg Crystal Spectrometer; WBS: Wide Band Spectrometer; ISAS: Institute of Space and Astronautical Science; JAXA: Japan Aerospace Exploration Agency; IDL: Interactive Data Language

Introduction

The sun, because it is so near, can be observed in infinitely greater detail than any other star. The *Yohkoh* satellite mission was flown to study high-energy solar processes, especially flares, eruptions, and the heating of the solar corona. *Yohkoh* was a mission of ISAS (one of the four principal bodies of JAXA) in Japan with cooperation of the United States and the United Kingdom. Scientific operation of Yohkoh extended from September 1991 (within the peak of sunspot cycle 22) to December 2001 (peak of sunspot cycle 23), thus covering all levels of solar activity. Raw and reduced observational data, along with all relevant operational information, from *Yohkoh* are housed in the internet-accessible YLA at http://solar.physics.montana.edu/ylegacy/. The following sections will briefly present the experimental capability of *Yohkoh* and the story of the creation and contents of the YLA.

Discussion

The *Yohkoh* mission.

ISAS, in 1981, launched Japan's first solar space mission, named *Hinotori,* a small spinning satellite, with great success. Their next solar mission, which was named *Yohkoh* (sunlight) after launch, was much more ambitious. It was a 3-axis stabilized spacecraft pointed at the sun. The *Yohkoh* instruments are described in Table 1. They all observed at short wavelengths to study high energy phenomena associated with solar activity.

Table 1: Yohkoh Scientific Instruments.

Hard X-ray Telescope (HXT)	
Instrument	Fourier-synthesis type Collimator (64 elements)
Energy Bands	15-24-35-57-100keV (4 bands)
Angular Resolution	~5 arc sec
Field of View	Full solar disk
Effective Area	~70 cm^2
Time resolution	0.5s
Soft X-ray Telescope (SXT)	
Instrument	Modified Wolter type I grazing incident mirror + CCD with coaligned optical telescope
Wavelength Range (X-ray)	3-60Å (selectable with filters)
(Optical)	4600-4800Å or 4293-4323Å
Angular Resolution	~2.5 arc sec
Field of View	Full solar disk

Time Resolution	Up to 0.5s
Wide Band Spectrometer (WBS)	
Detectors	Gas Proportibnal Counter (Soft X-rays; 2-30keV), Nal Scintillation Counter (Hard X-rays; 20-400keV), BGO Scintillation Counter (Gamma-rays; 0.2-100MeV)
Time Resolution	(Count-Rate Data) 0.125, 0.25, or 0.5s (Pulse-Height Spectrum Data) 1, 2, or 4s
Bragg Crystal Spectrometer (BCS)	
Instruments	Bent Crystal Spectrometers
Spectral lines and Resolutions	
S xv (5.0385Å)	5.0160-5.1143Å with 3.232mÅ Resolution
Ca xix (3.1769Å)	3.1631-3.1912Å with 0.918mÅ Resolution
Fe xxv (1.8509Å)	1.8298-1.8942Å with 0.710mÅ Resolution
Fe xxvi (1.7780Å)	1.7636-1.8044Å with 0.565mÅ Resolution
Time Resolution	Up to 0.125s

Pre-launch papers describing the mission and the *Yohkoh* instruments are available through the YLA under "Documentation, Papers from the Red Book". *Yohkoh* observed the sun from September 1991 until December 14, 2001. The HXT and SXT produced solar images unprecedented in angular resolution, time resolution and short wavelength (i.e., high temperature) response.

The Yohkoh Legacy Archive

Data and data products from the *Yohkoh* mission may be found at http://darts.isas.jaxa.jp/solar/yohkoh/ and http://umbra.nascom.nasa.gov/yohkoh/. However, the user-friendly YLA at http://solar.physics.montana.edu/ylegacy/ is the most extensive and up-to-date archive. For the WBS and BCS the YLA presents flare catalogs and additional information. For the HXT the catalog includes hard x-ray images of the larger flares and x-ray light curves of many (3071) flares between October 1, 1991 and December 14, 2001.

All level-0 *Yohkoh* data are available for analysis on the YLA through the use of IDL routines available through Solar Soft. A link to Solar Soft is on the YLA under "Data link: Level_0."

For SXT, the YLA provides not only level-0 but also level-1 (reduced and corrected solar x-ray images in both full-sun and partial-disk formats), level-2 (composite full-sun images designed to cover a wider intensity range than is possible with single exposures), and level-3 (level-2 images further normalized and aligned for the making of time-lapse movies). The YLA includes annual and mission-long "smoothies", i.e., movies made to exhibit a smoothly rotating sun through the interpolation of SXT level-3 full-sun images. The level-1 and level-2 SXT data are presented in instrumental units. IDL programs are available to convert these data to physical units. Figure 1 illustrates an SXT coronal image assembled from individual level-2 images.

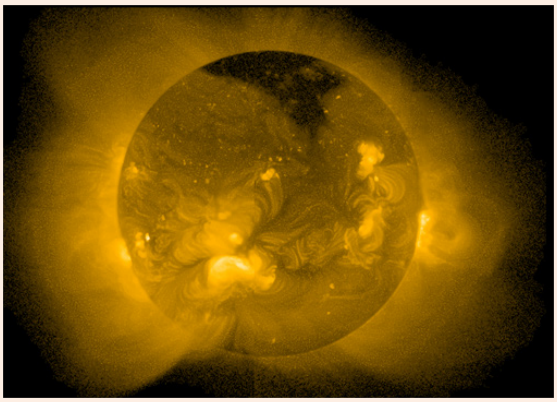

Figure 1: This image shows the solar x-ray corona on May 8, 1992.

The effective wavelength of Figure 1 is about 1nm and the resolution is about 10arc sec. The image was made deeper and wider by combining several images with different exposure times and different telescope pointing. An x-ray image like this has a total intensity range on the order of 10,000, requiring a logarithmic compression to bring all of its features into view simultaneously.

An exhaustive discussion of the calibrations and corrections that have been applied to the SXT images has been published by Acton (1). This reference is available through the YLA.

Conclusion

The YLA, which took over a decade to complete, provides a rich source of information for solar researchers as well as resource for anyone interested in the beauty and magnificence of the active sun. A visit to the YLA should prove rewarding for all.

Citation: Acton LW (2017) The Yohkoh Legacy (Data) Archive. Phys Astron Int J 1(3): 00019. DOI:10.15406/paij.2017.01.00019

Acknowledgement

Dr. Aki Takeda made major contributions to the creation of the YLA, including design of the form and format. Participation of U.S. scientists in the *Yohkoh* mission has been provided by the National Aeronautics and Space Administration for a period of about 20 years.

Conflict of Interest

Author declares there is no conflict of interest.

References

1. Loren W Acton (2016) On-Orbit Performance and Calibration of the Soft X-Ray Telescope on Yohkoh. Solar Physics 291(2): 643-703.