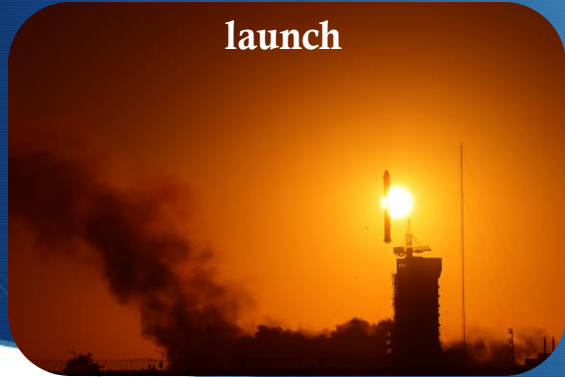




# ASO-S Mission: Status and Early Results (+ future synergies with PUNCH and other coronagraphs)

launch



Jie Zhao on behalf of ASO-S Team  
Email: [zhaojie@pmo.ac.cn](mailto:zhaojie@pmo.ac.cn)  
Purple Mountain Observatory, CAS



# Outline



**ASO-S mission and three  
payloads**



**ASO-S data: browse, download &  
analyze**

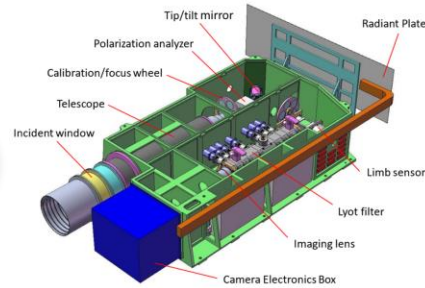
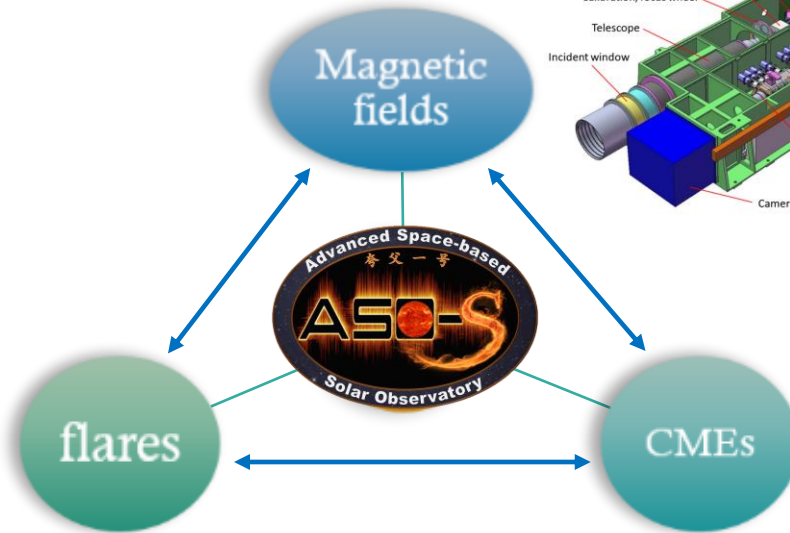
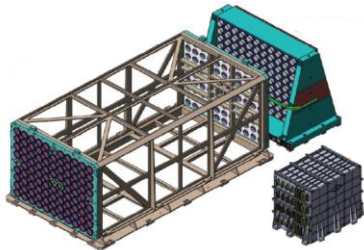


**Coordinated observations with  
PUNCH and other instruments**

# ASO-S: overview

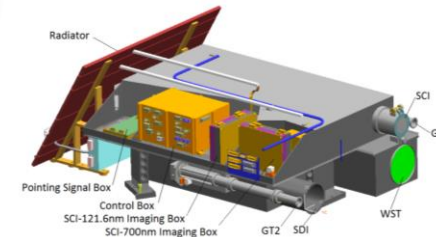
Scientific objectives: '1M2B' – magnetic field and two bursts: flare and CME

**HXI:**  
Hard X-ray Imager

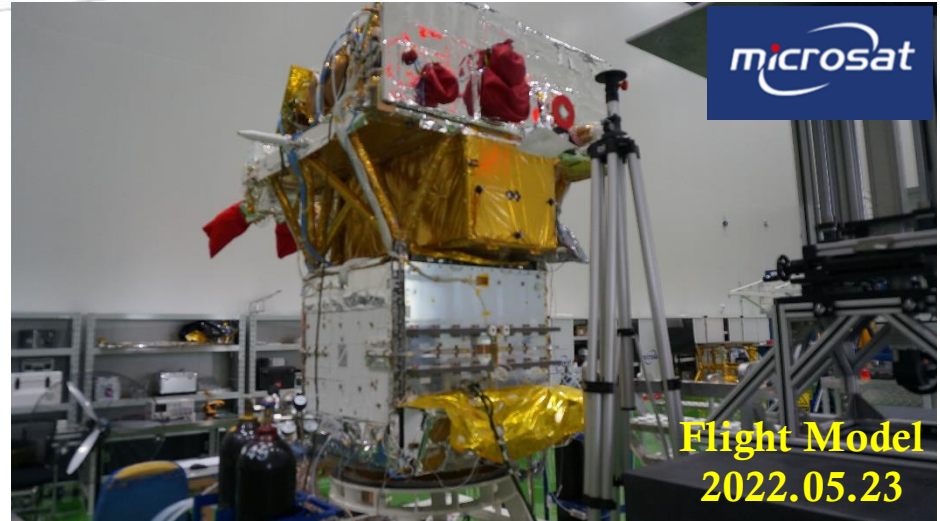


**FMG:**  
Full-disk MagnetoGraph

**LST:**  
Lyman-alpha Solar Telescope



# ASO-S: overview

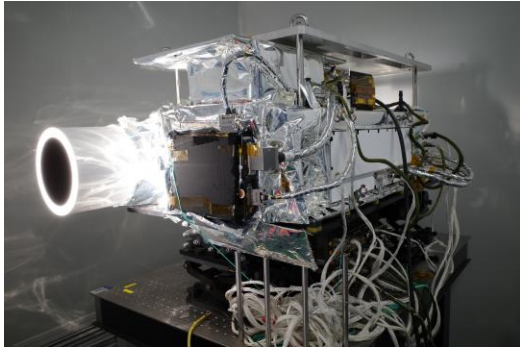


**Orbit:** sun-synchronous  $98.275^\circ$   
**Attitude:** 720 km  
**Descending node:** 6:00AM

**Pointing accuracy:**  $0.01^\circ$   
**Stability:**  $0.0005^\circ/\text{s}$   
**Total Mass:**  $\sim 888$  kg

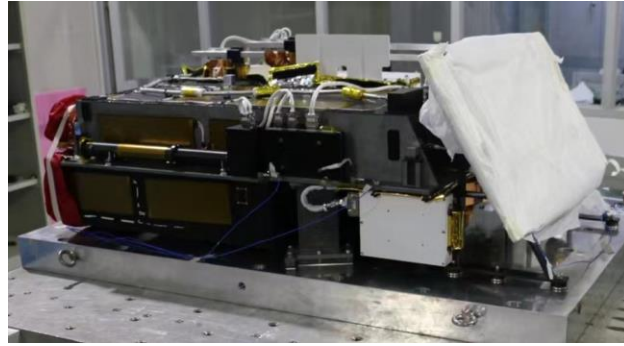
**Data:**  $\sim 500$  GB/day  
**Carrier:** LM-2D at Jiuquan  
**Launch:** **Oct. 2022** >4Y

# ASO-S: payloads



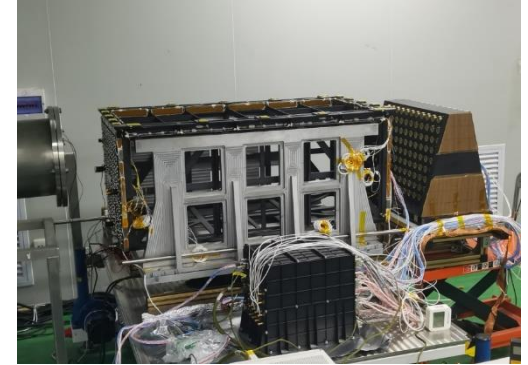
## FMG:

- photospheric Magnetic field



## LST:

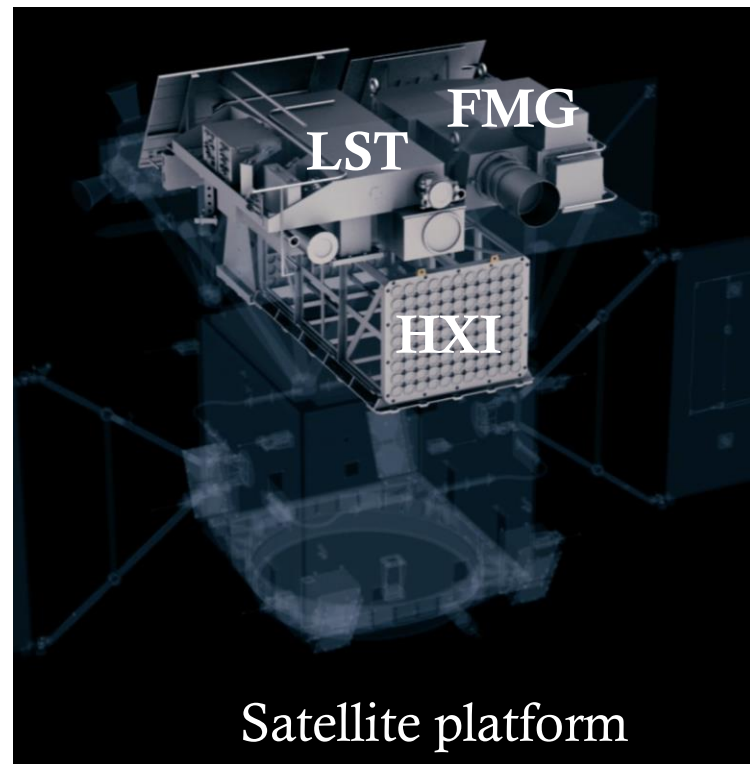
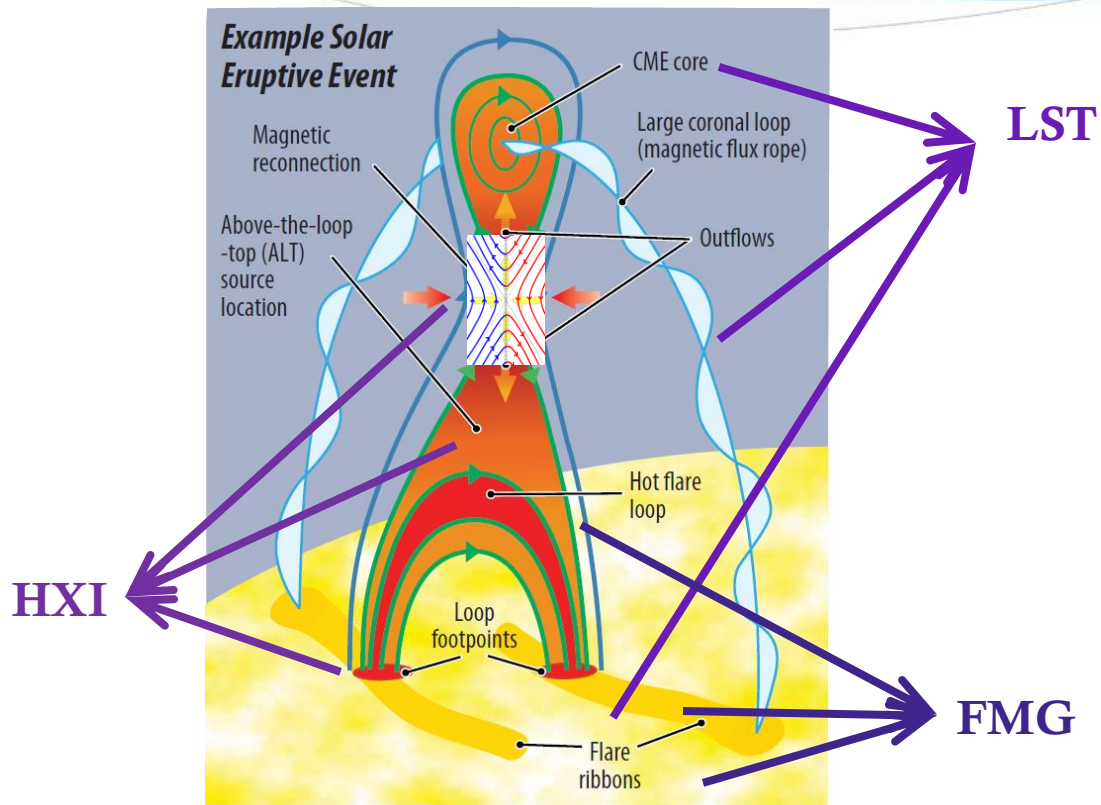
- White light image (360 nm)
- Full disk Ly $\alpha$  image
- Ly $\alpha$ +white light coronagraph



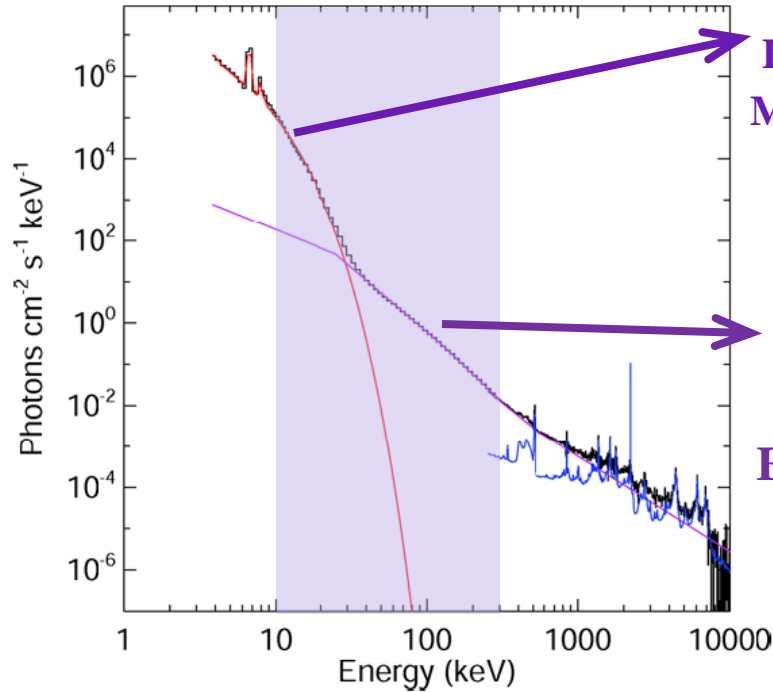
## HXI:

- Hard X-ray spectra
- Hard X-ray images

# ASO-S: payloads



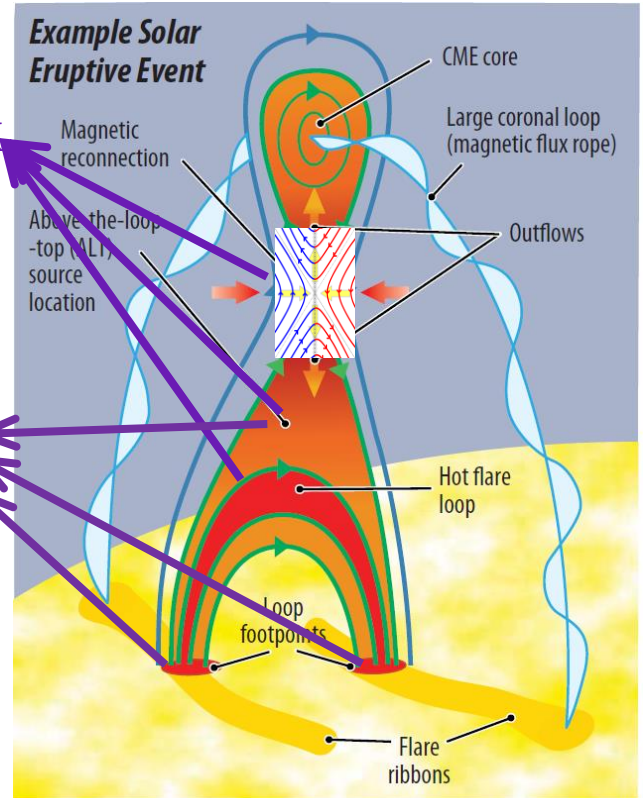
# ASO-S/HXI overview



John C. Raymond et al. 2012, Lin 2011

**Thermal emission:**  
**Plasma heated to a few MK to a few tens of MK**

**Non-thermal  
Bremsstrahlung  
emission:**  
**Energetic electrons**

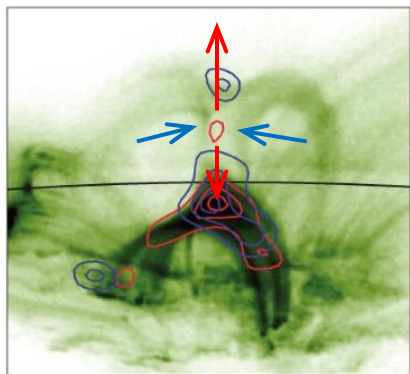


# ASO-S/HXI overview

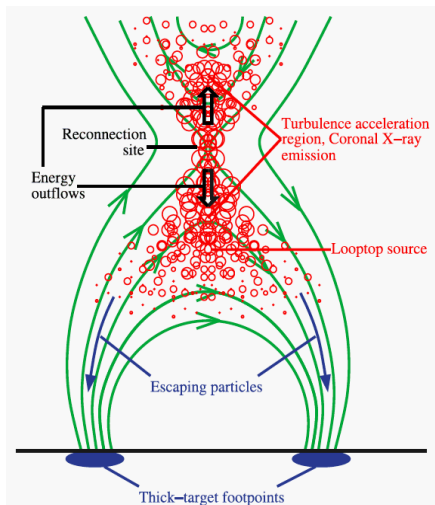
**HXI: To observe solar hard X-ray spectra and images**

Krucker and Battaglia, 2014

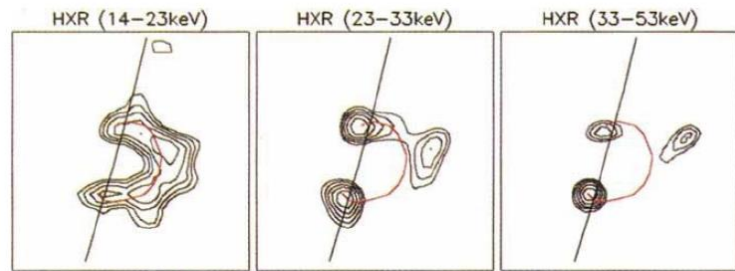
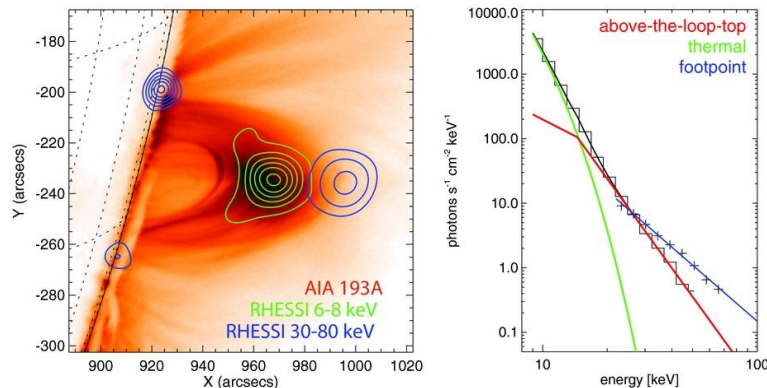
- Energy release and Plasma heating
- Energetic particles
- Magnetic reconnection



Su + 2013, Nature Physics



Liu et al. 2013 8



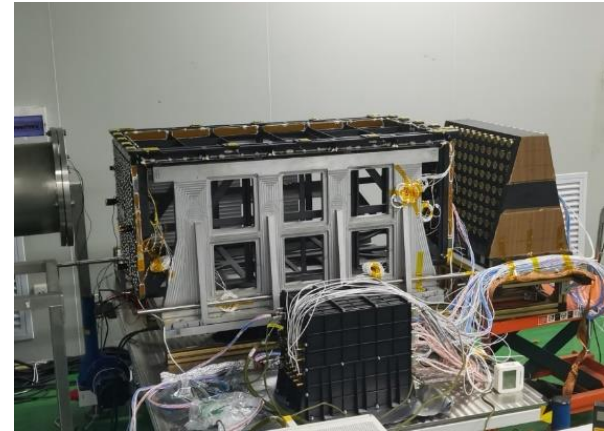
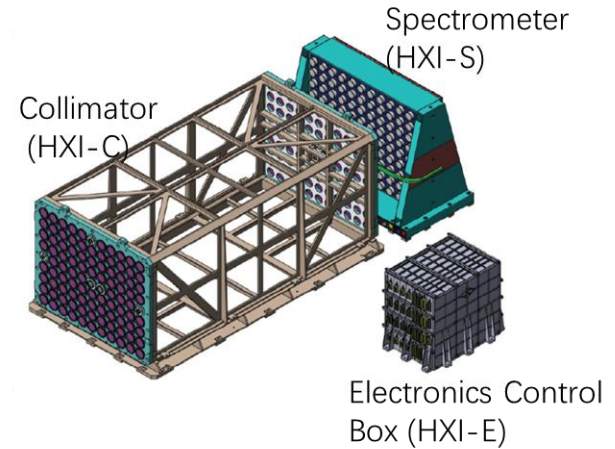
Masuda et al. 1994, Nature



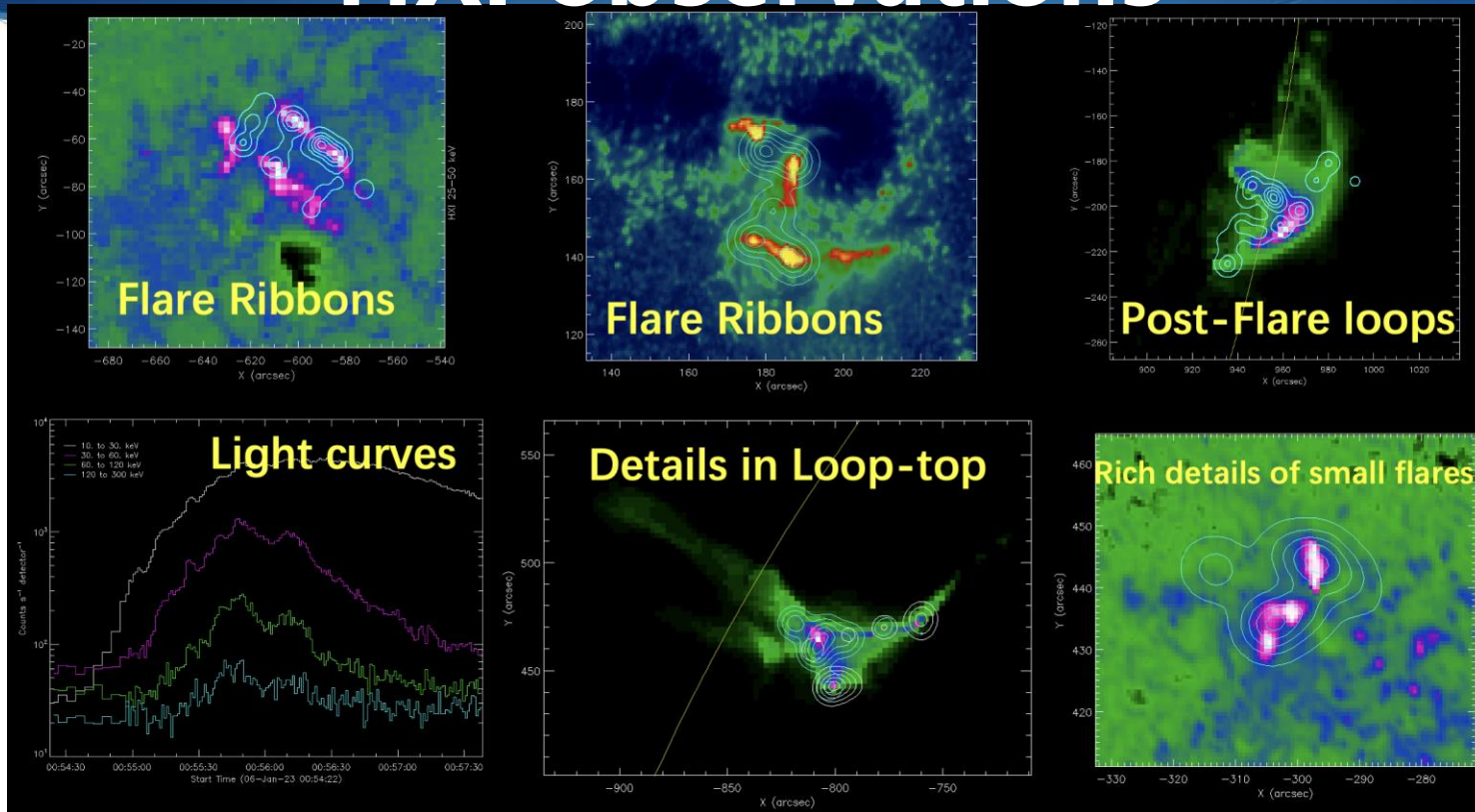
# ASO-S/HXI overview

## HXI specifications

<b>energy range</b>	~ 10 -300 keV (spectra) ~ 15 -284 keV (imaging)
<b>Spatial resolution</b>	~ 3.1 arcsec
<b>Energy resolution</b>	better than 22%@32keV
<b>Temporal resolution</b>	0.125 – 4s (shorter cadence for burst mode)
<b>Grid pitch</b>	10 groups from 36 to 1224 $\mu\text{m}$
<b>subcollimators</b>	91
<b>Detectors</b>	99 $\text{LaBr}_3$ detectors imaging: 91 / BKG: 5 / Total flux: 3
<b>Twist</b>	~1 arcsec
<b>Temperature diff.</b>	< 1°C
<b>Pointing accuracy:</b>	Better than 0.3 arcsec Time resolution: 0.25 s



# HXI observations



**HXI:** it works very well, and its performance is exactly the same as or even better than that designed, e.g., energy range, spatial resolution.....

# ASO-S/FMG overview

**FOV** : Full-disk (34')

FWHM : 0.011nm

Spectral line: FeI532.4nm

**Aperture**: 14cm

**Spatial Res.:** 1.5" ;

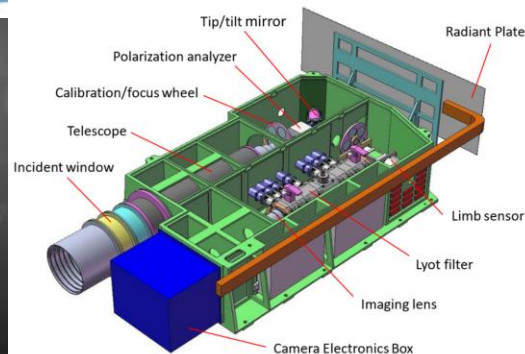
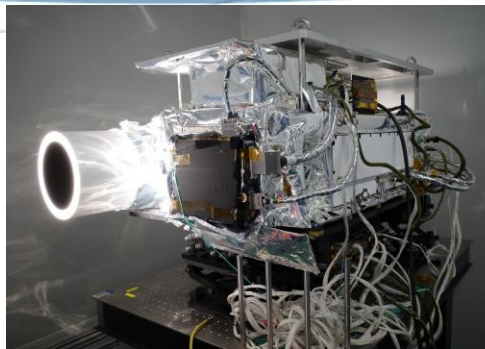
**Detector**: CMOS, 4096×4096

**Temporal res/:** Normal mode: 2 min

Burst mode: 40 s

**Longitudinal Sensitivity** : 9 Gauss

**Polarization sensitivity**: 0.0005/1080s

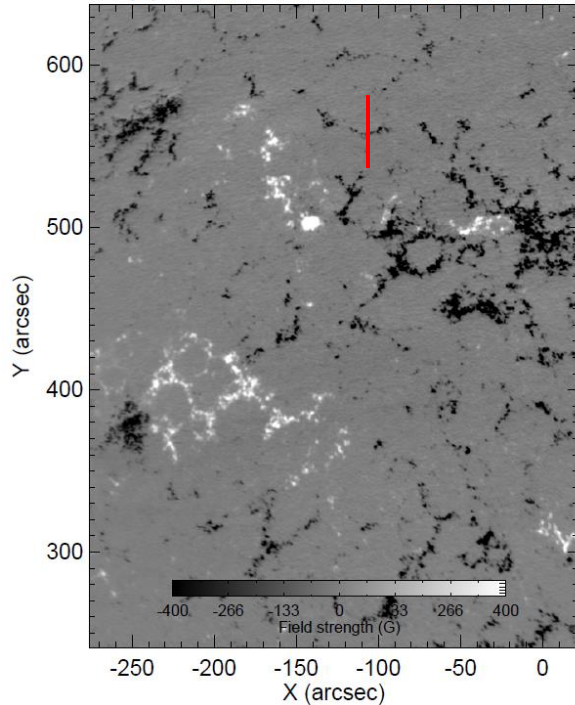


**FMG**:  $B_{\perp}$  for a local region looks good! However, one of the liquid crystals doesn't seem to work as expected, resulting in the lack of  $B_{\parallel}$  for the normal mode of observations. The quality of full disc image is also influenced in some degree by a darker region.

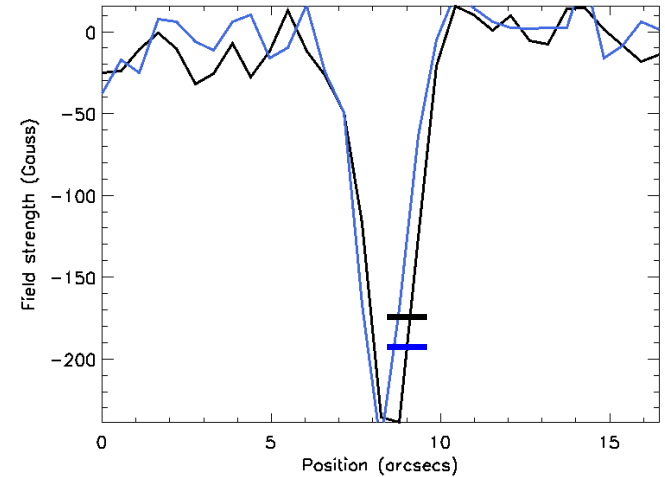
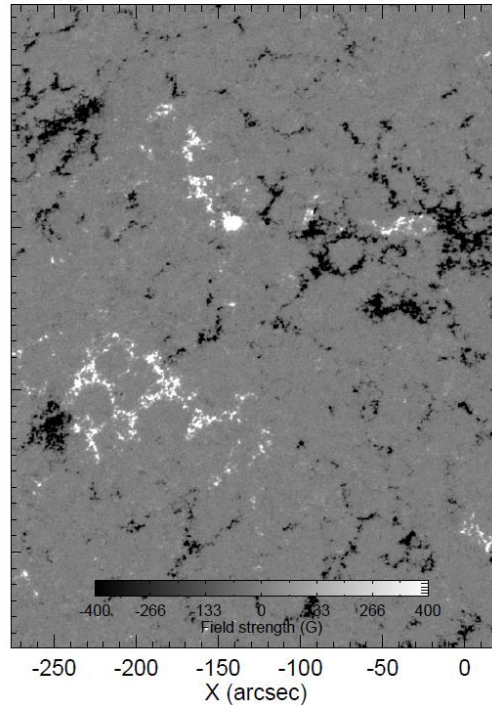
# ASO-S/FMG overview

FMG LOS magnetic field (Gan et al. Sol.Phys., 2023)

(a) FMG 2022-11-06 00:50:15 UT



(b) HMI 2022-11-06 00:44:10 UT

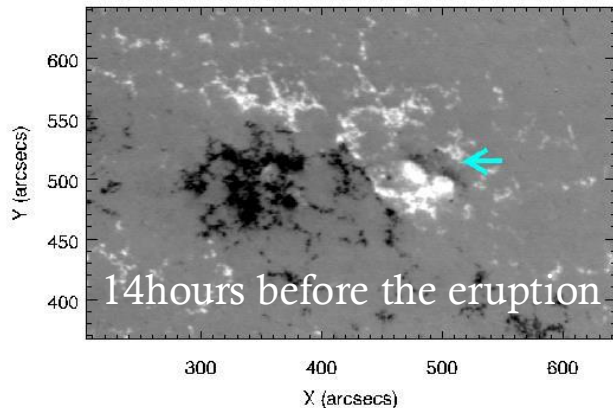


**HMI FWHM=1.48"**

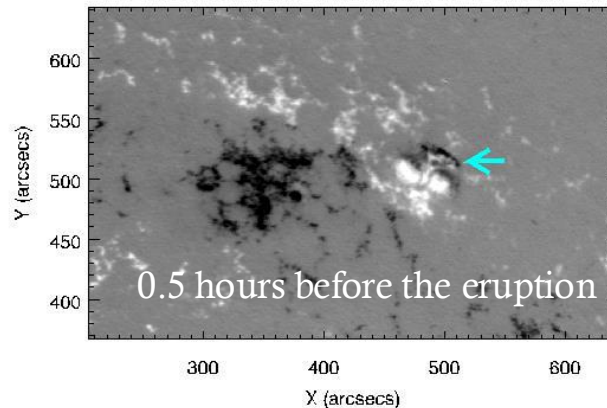
**FMG FWHM=1.53"**

# FMG observations

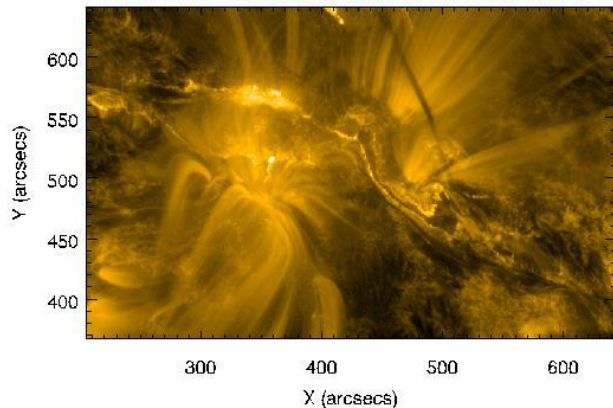
FMG magnetogram at 2023-02-24T06:45:36 UT



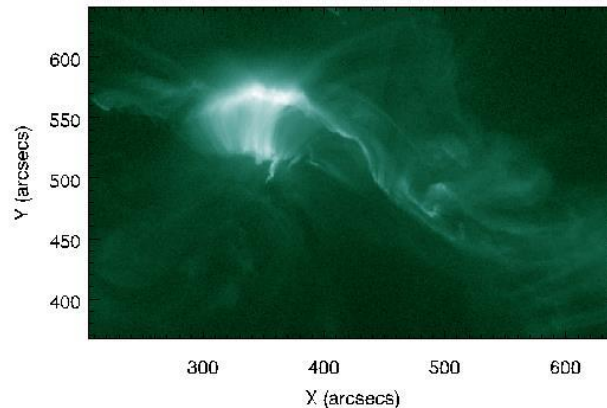
FMG magnetogram at 2023-02-24T19:00:32 UT



M3.7 flare by AIA 171 A at 2023-02-24T20:30:09 UT



M3.7 flare by AIA 94 A at 2023-02-24T20:29:59 UT



# ASO-S/LST overview

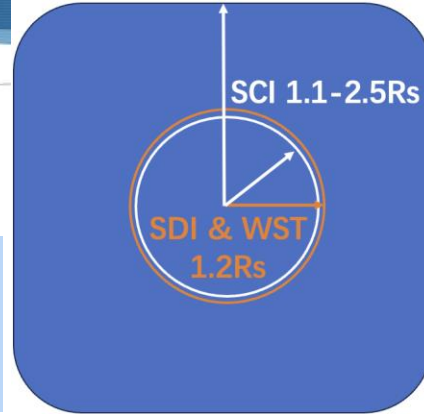
## LST instruments

SCI: Solar Corona Imager

SDI: Solar Disk Imager

WST: White-light Solar Telescope

SCI does not work as expected. However, it can sometimes observe eruptive prominences and CMEs in Ly $\alpha$ .



parameters

WST

SDI

SCIUV

SCIWL

waveband

$360 \pm 2\text{nm}$

$121.6 \pm 4.5\text{nm}$

$122.6 \pm 3\text{nm}$

$700 \pm 32\text{nm}$

FOV

0 – 1.2 Rs

0 – 1.2 Rs

1.1 - 2.5 Rs

1.1 - 2.5 Rs

Image size

4608×4608

4608×4608

2048×2048

2048×2048

cadence

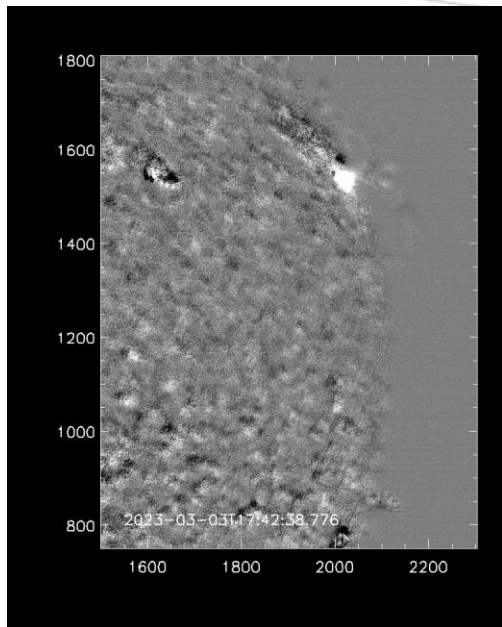
routine (2min)  
burst (1s & 2s / 5s)  
user defined

routine (1min)  
burst (a few s/15s)  
user defined

Li+(2019) RAA  
Chen+(2019) RAA  
Feng+(2019) RAA

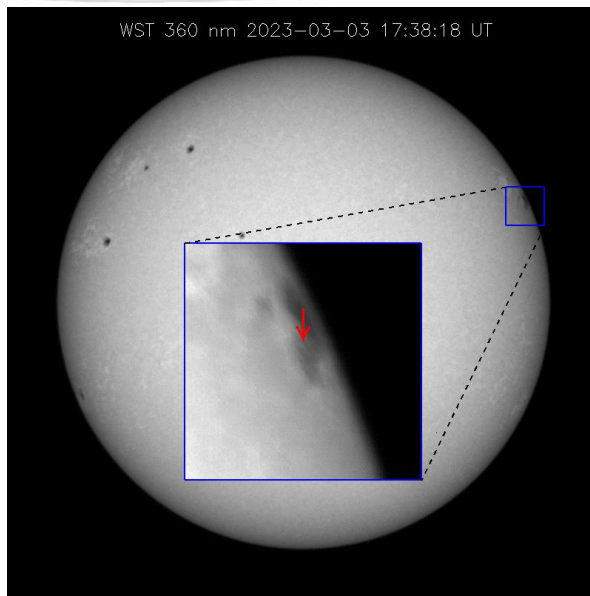
# SDI

## Ly $\alpha$ flare and wave



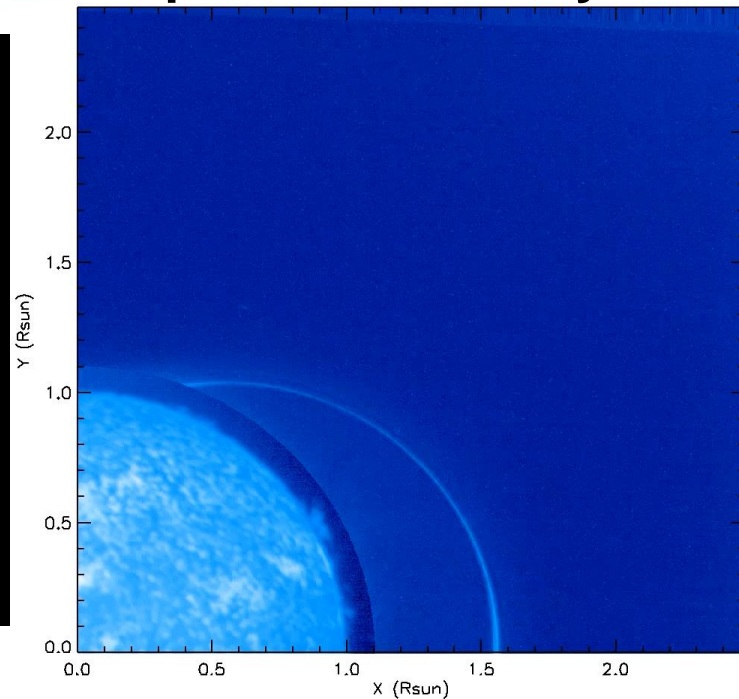
# WST

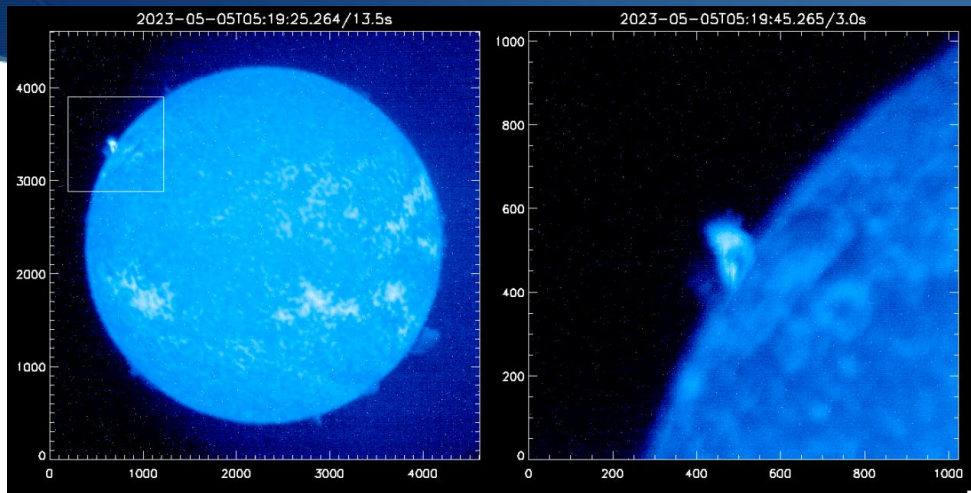
## white-light flare



# SCI

## prominence in Ly $\alpha$



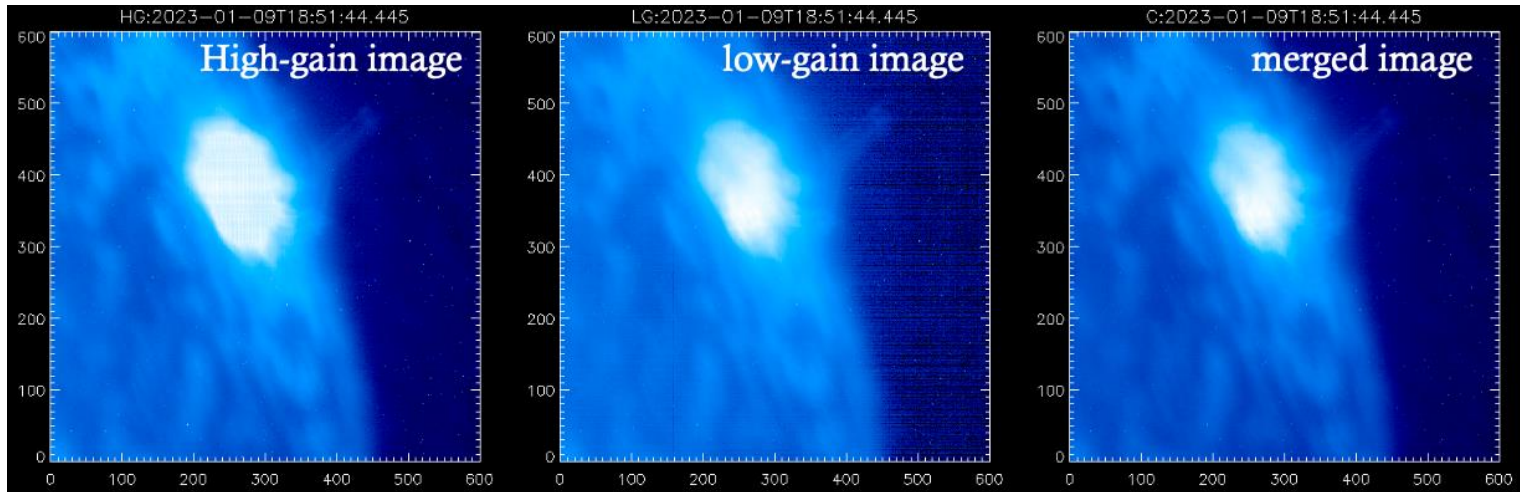


# SDI burst mode

Image window: 1024\*1024

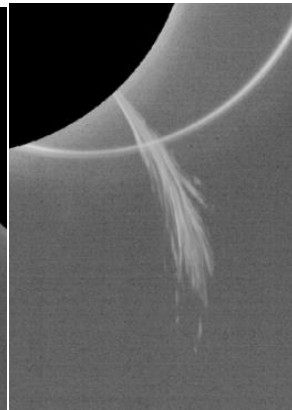
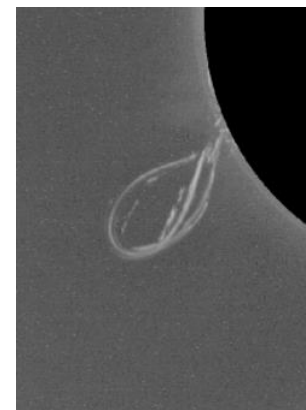
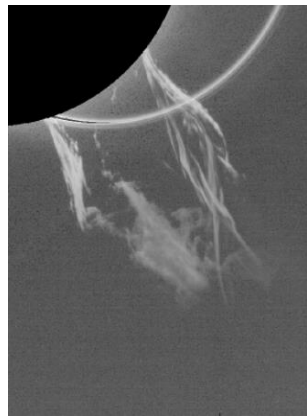
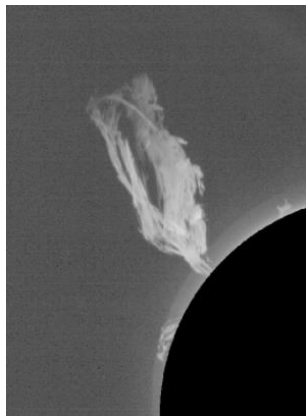
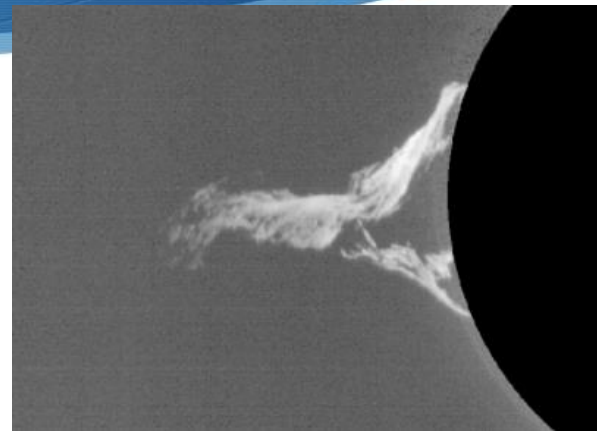
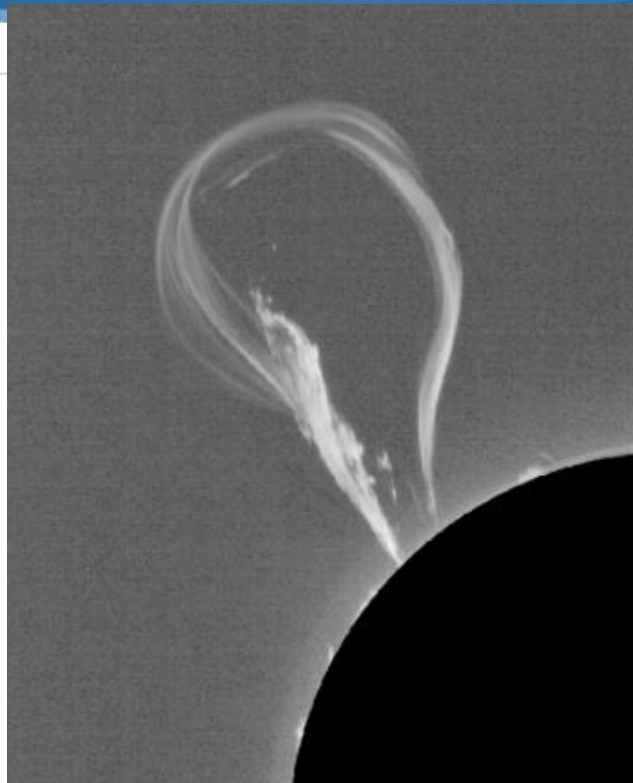
Higher cadence: 4s

High dynamic range imaging

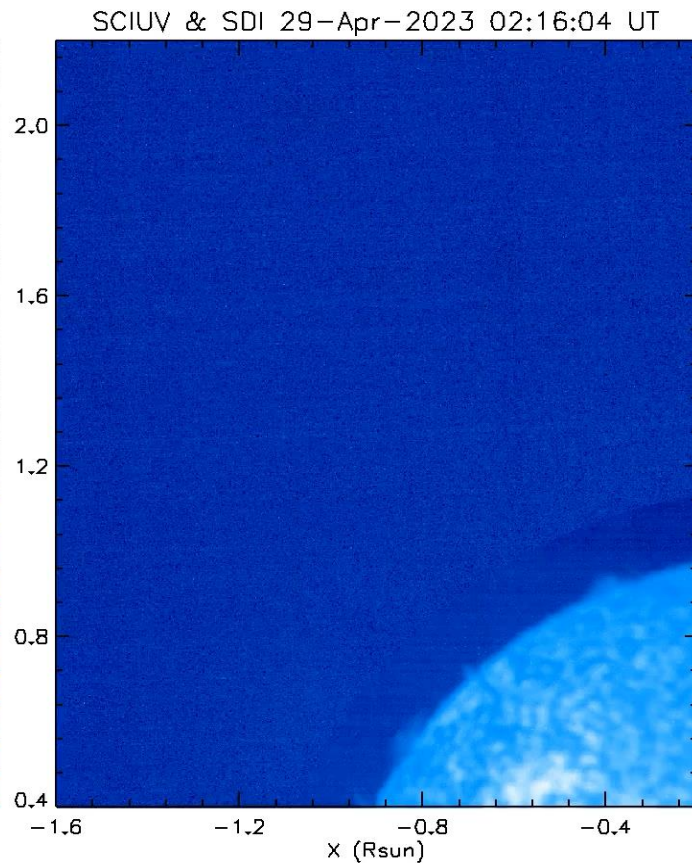
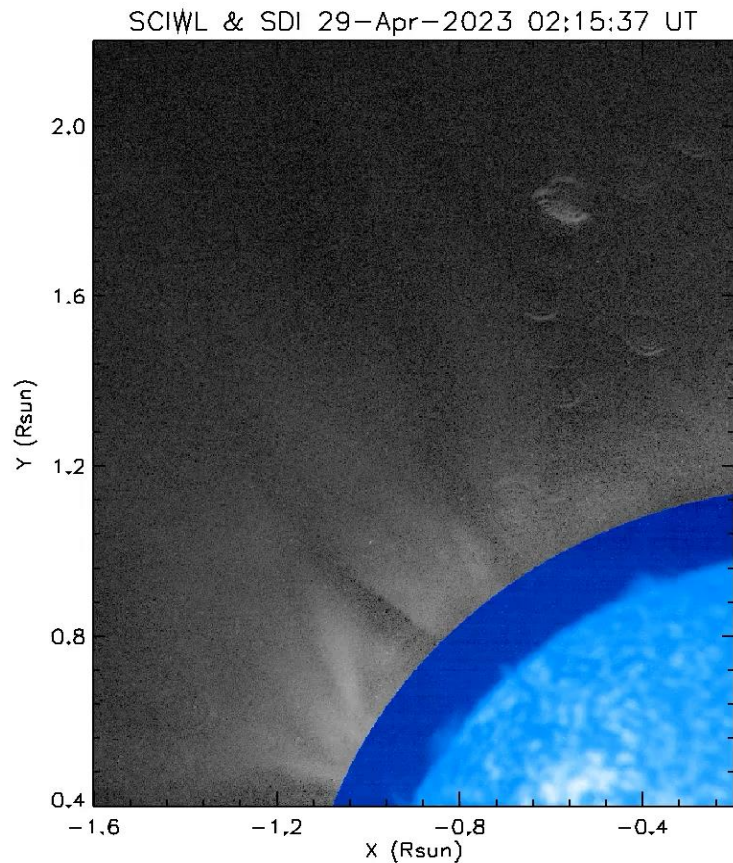




# Prominences in Ly $\alpha$ observed by SCI

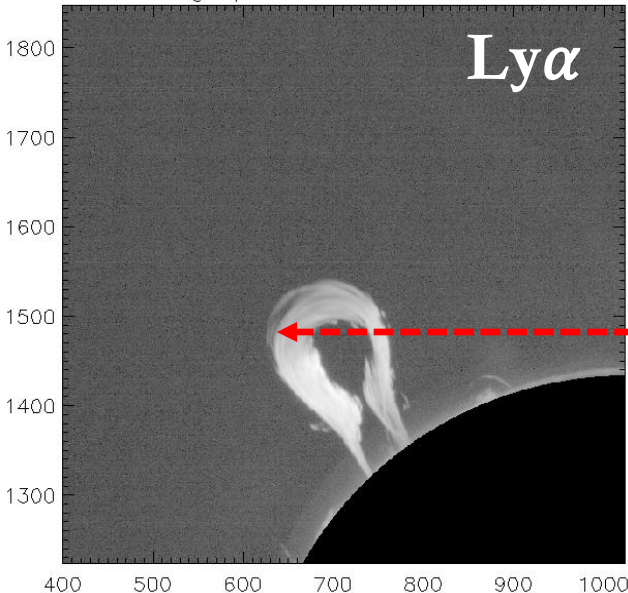


# Seamless observations in Ly $\alpha$ by SDI and SCI

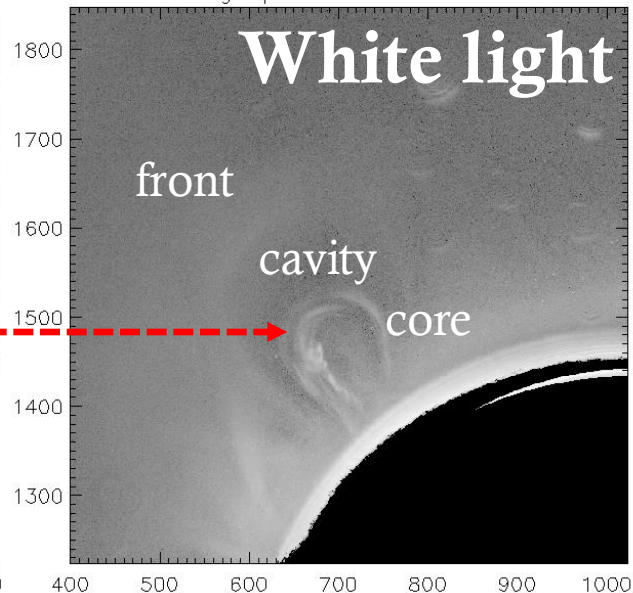


# SCI dual-waveband observations

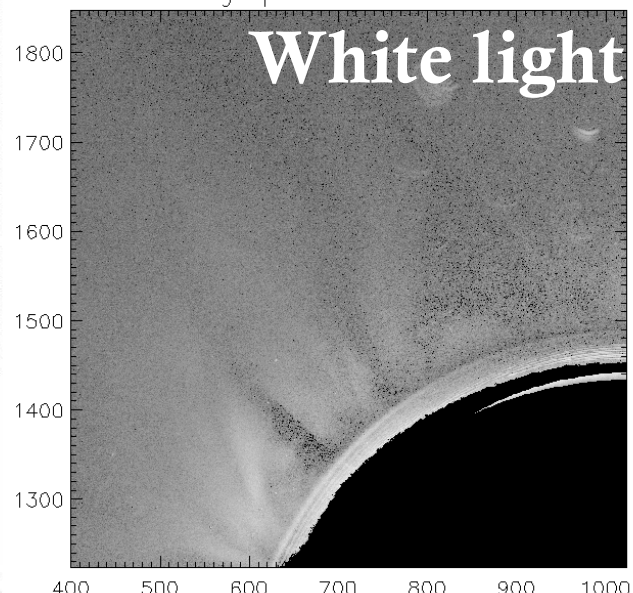
SCIUV Longexp: 2023-04-29T03:05:34.671



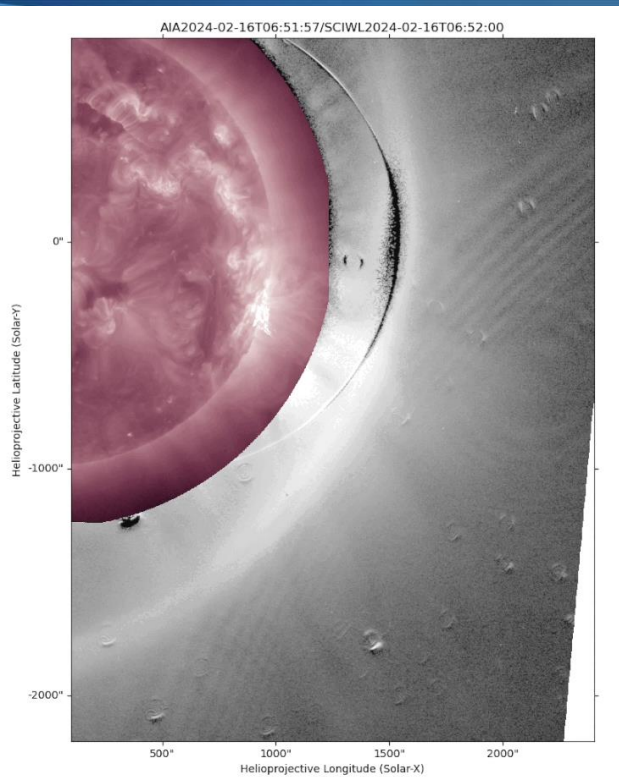
SCIWL LG Longexp: 2023-04-29T03:05:37.471



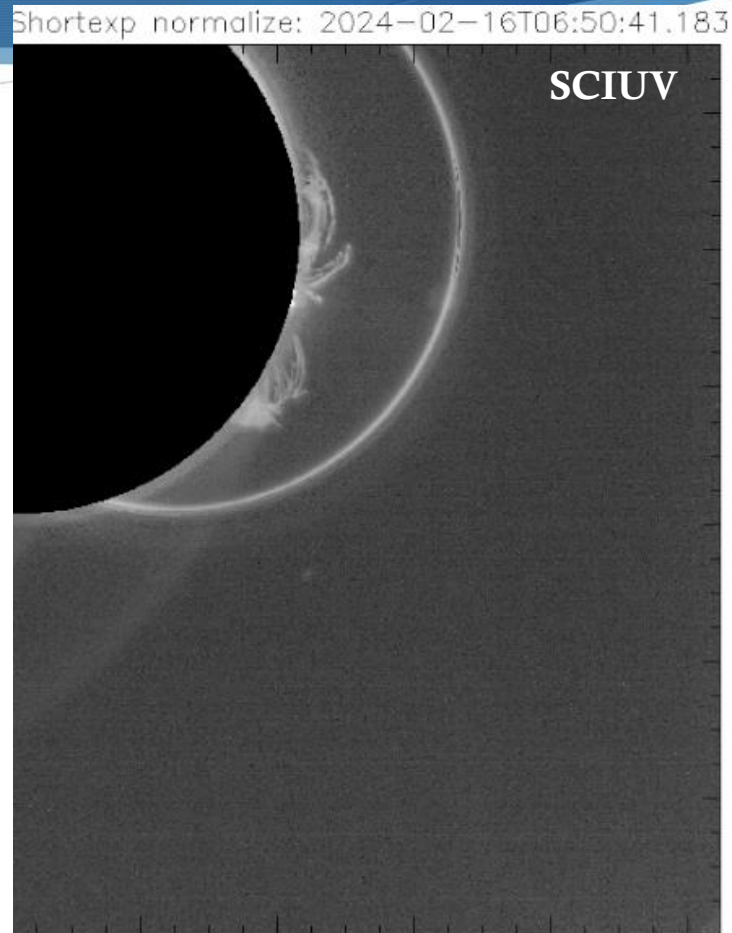
SCIWL LG Longexp: 2023-04-29T02:01:37.485



# SCI dual-waveband observations



**2024-02-16**  
**AIA/193 + SCIWL**



# SDI synoptic map

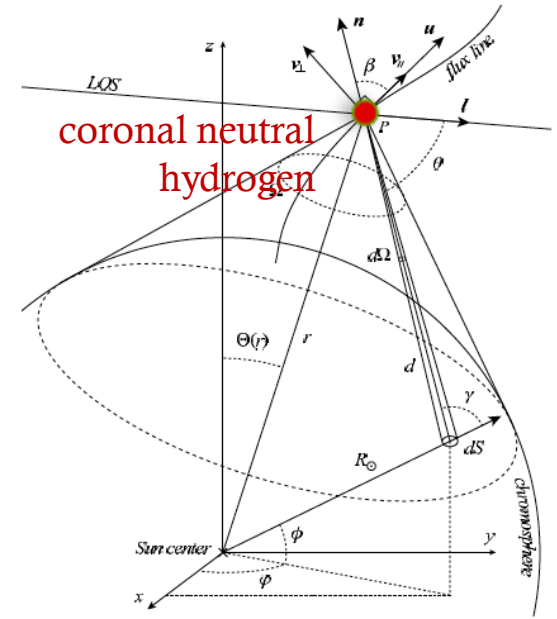
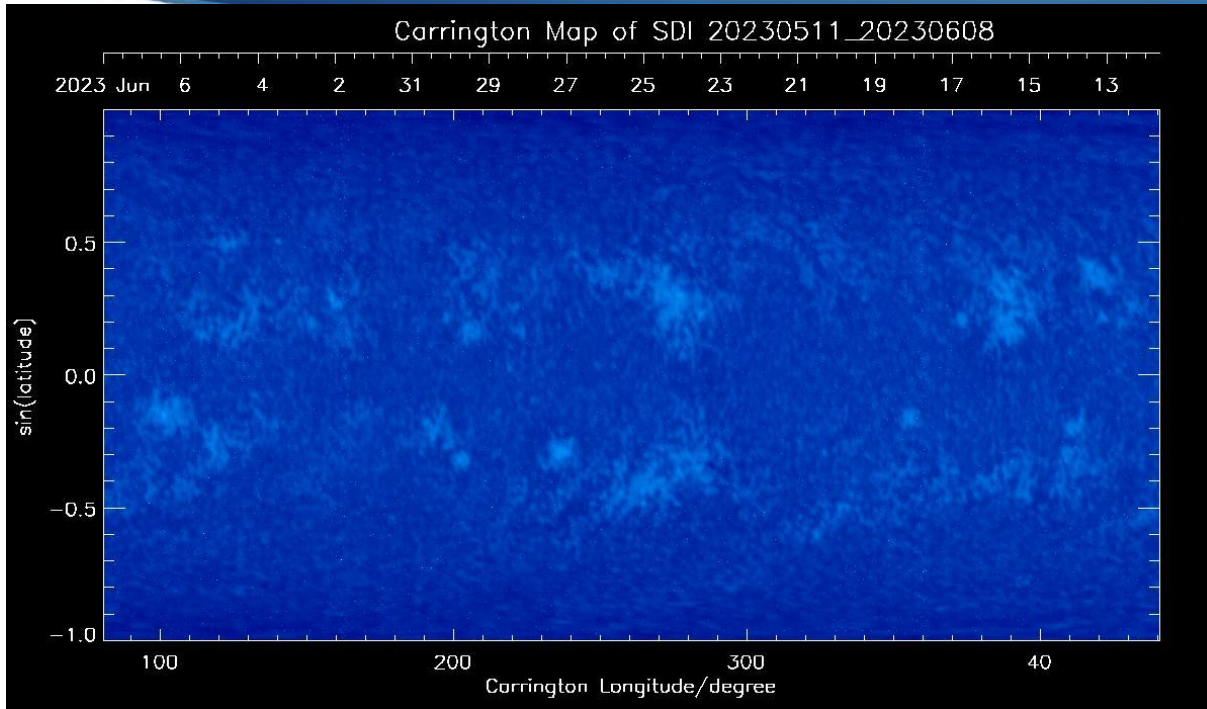


FIG. 1.—Geometry of the modeling of the resonantly scattered coronal Ly $\alpha$  radiation.

**Provide incident low-atmosphere Ly $\alpha$  emission for coronal Ly $\alpha$  emission**

# ASO-S data: browse, download & analyze

## Data Release:

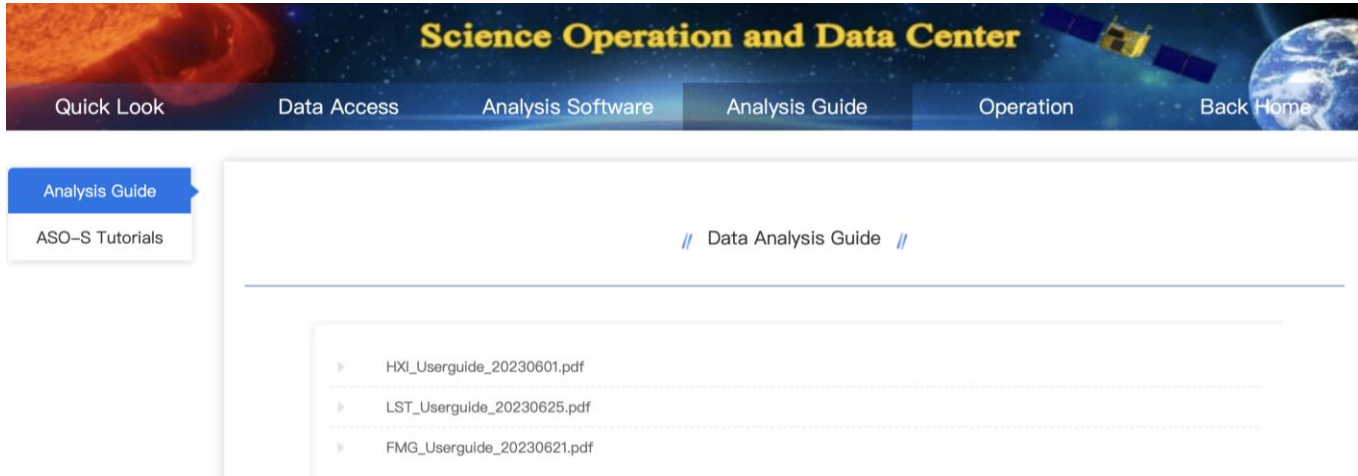
HXI, FMG, SDI & WST data since April 1<sup>st</sup> 2023 are released near real-time.

Image browser: <http://aso-s.pmo.ac.cn/sodc/imageBrowser.jsp>

Data download: <http://aso-s.pmo.ac.cn/sodc/dataArchive.jsp>

User guide: <http://aso-s.pmo.ac.cn/sodc/analysisGuide.jsp>

Data Software: via Solarsoft ware or <http://aso-s.pmo.ac.cn/sodc/analysisSoftware.jsp>



The screenshot displays the 'Science Operation and Data Center' website. The header features a navigation menu with 'Quick Look', 'Data Access', 'Analysis Software', 'Analysis Guide' (selected), 'Operation', and 'Back Home'. A sidebar on the left contains 'Analysis Guide' and 'ASO-S Tutorials'. The main content area is titled 'Data Analysis Guide' and lists three user guides for download:

- ▶ [HXI\\_Userguide\\_20230601.pdf](#)
- ▶ [LST\\_Userguide\\_20230625.pdf](#)
- ▶ [FMG\\_Userguide\\_20230621.pdf](#)

# daily movies & image browser

## Lastest (Daily images/movies)

The data start from April 1, 2023.

Date:

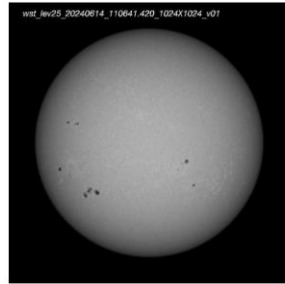
### LST

SDI



Download

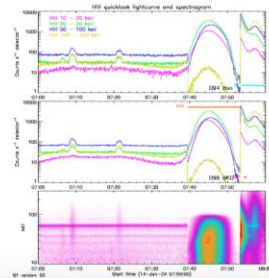
WST



Download

### HXI

HXI



## Image Browser

The data start from April 1, 2023.

Image Type  FMG NOAA AR Number  (Only input the digits here.)

Display one image per x  (numeric(eg, 1 per 10 images), 'hour' or 'day')

Start Date  End Date  Display

Count: 919

Email:

If no data is shown. Please adjust the date range.

1/919

sci\_lev15\_20240607\_000021.324\_1024X1024\_v01

Prev Slower Play Stop Backward Faster Next

# data download: Data Archive

## Data Archive

The ASO-S data policy can be found [here](#).

The SDI data is between April 2, 2023 and April 3, 2023. The other data starts from April 1, 2023.

Start Time

04/02/2023 03:00 

End Time

04/02/2023 04:00 

HXI ?

Level Q1

Hourly Fits  Hourly Png  Data-production status Png

Level 1

Detector Data

FMG ?

Level

2-AR

Mode

Routine  User-defined Cadence  s

LST ?

SDI Level

1  Background

SDI Mode

Routine  Burst-1024  Burst-4608  User-defined Cadence  s

WST Level

1

WST Mode

Routine  Burst-1024  Burst-4608  User-defined Cadence  s

Email:

 Search

 Tar and Download Data

 Reset

Request File Count : 60

Probable Size(KB) : 1361866

Request ID : 20230410182939184003

### Data Export Status and Retrieval

Request ID :

 Check Status

Status :

Ready

Link :

<http://172.17.90.231:8080/downloadPackFits/20230410/20230410182939184003.zip>

 Download Link

	File Name	Download
1	sdi_lev10_20230402_030007.983_v01.fits.gz	<a href="#">download</a>
2	sdi_lev10_20230402_030107.983_v01.fits.gz	<a href="#">download</a>
3	sdi_lev10_20230402_030207.983_v01.fits.gz	<a href="#">download</a>



# data download: cutout service

## Cutout Service

The SDI data is between April 2, 2023 and April 3, 2023. The other data starts from April 1, 2023.

Start Time

04/03/2023 07:30



End Time

04/03/2023 09:30



LST ?

SDI Level

1

Cadence(optional)

User-defined Cadence  s

WST Level

1

Cadence(optional)

User-defined Cadence  s

Cutout

Xcenter (arcsec)

Ycenter (arcsec)

Xrange (arcsec)

Yrange (arcsec)

Tracking (optional)

Reference Time:

Requirement

The arcsec range for x-axis is between [-1150,1150].  $Xrange > 0$ ,  $Xcenter - (Xrange/2) \geq -1150$ ,  $Xcenter + (Xrange/2) \leq 1150$ .

The arcsec range for y-axis is between [-1150,1150].  $Yrange > 0$ ,  $Ycenter - (Yrange/2) \geq -1150$ ,  $Ycenter + (Yrange/2) \leq 1150$ .

Email:

Search

Submit

Reset

Result

File Count : 120

Probable Size(KB) : 2648510

Request ID : [20230410181031551001](#)

Data Export Status and Retrieval

Request ID :

Check Status

Status :

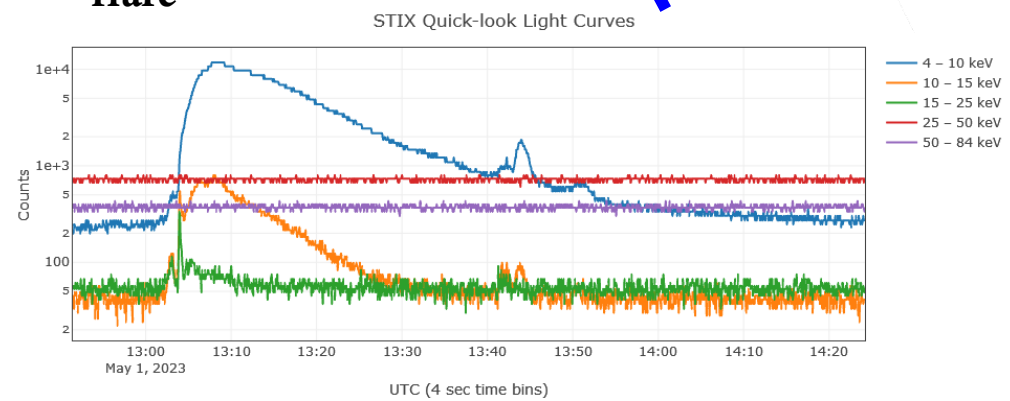
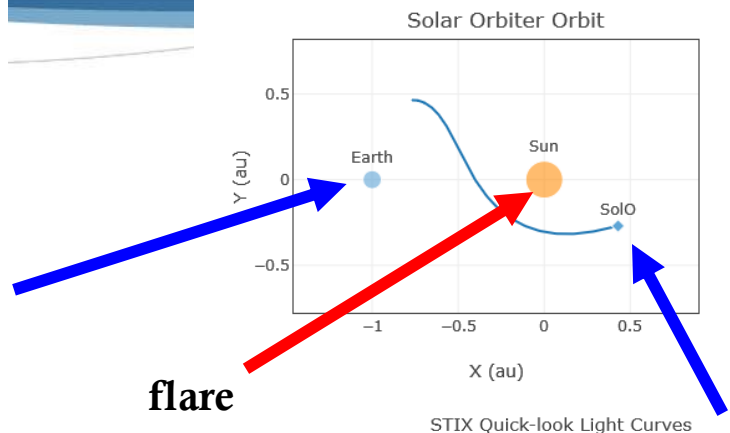
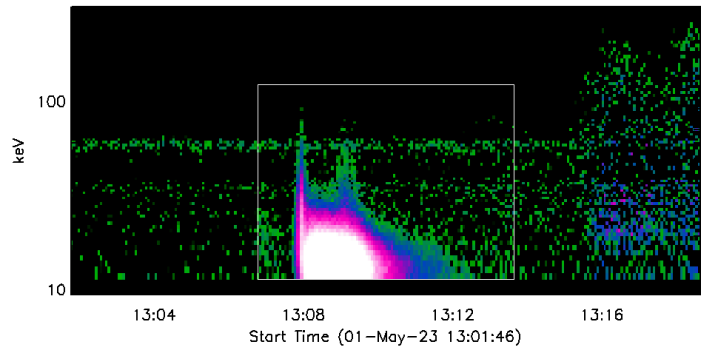
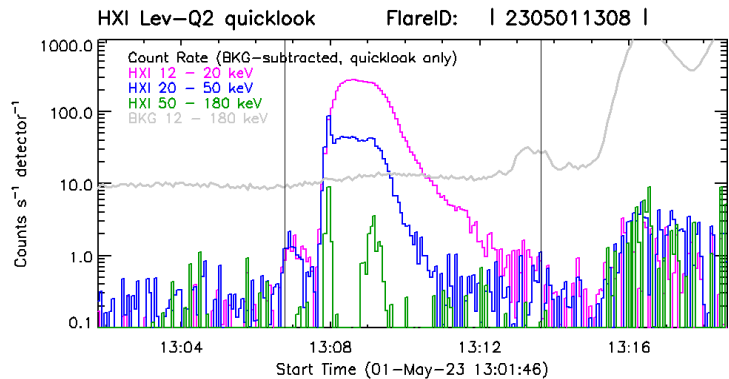
Ready

Link :

<http://172.17.90.231:8080/downloadCutout/20230410/20230410181031551001.tgz>

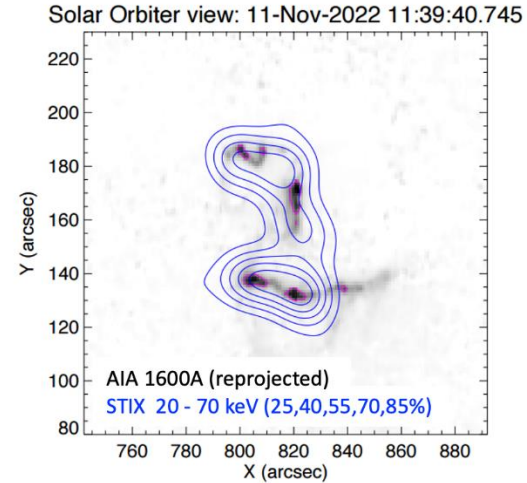
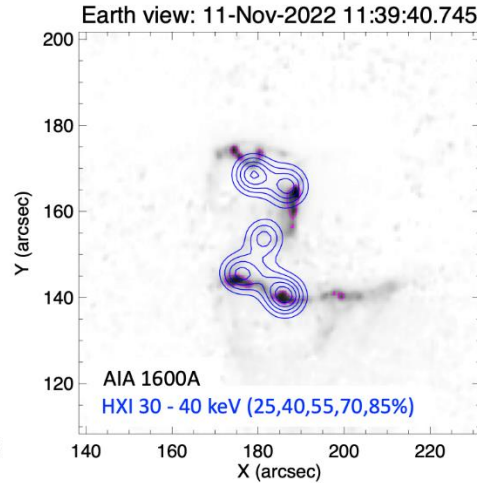
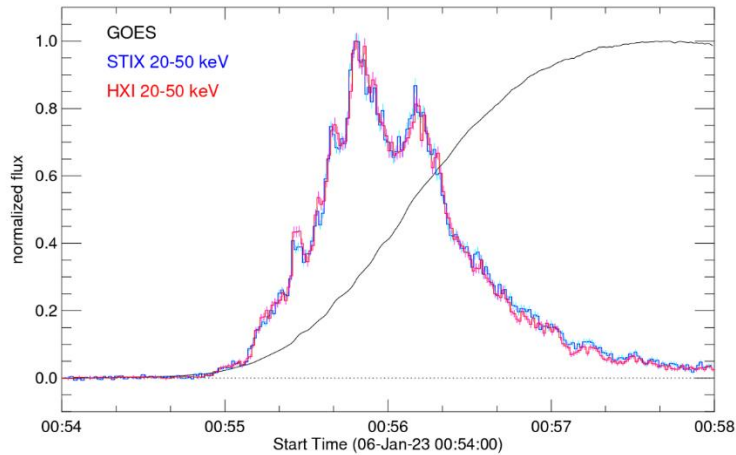
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# Coordinated observations: ASO-S/HXI & SoLO/STIX



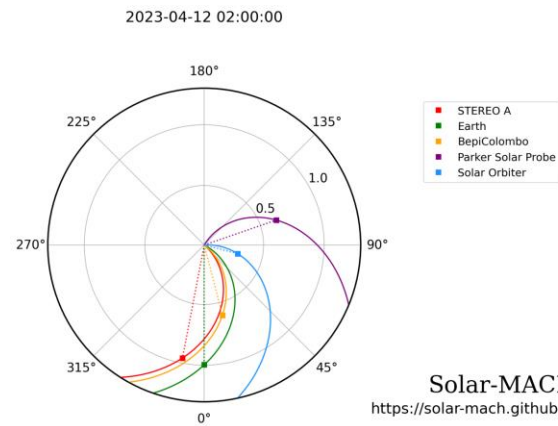
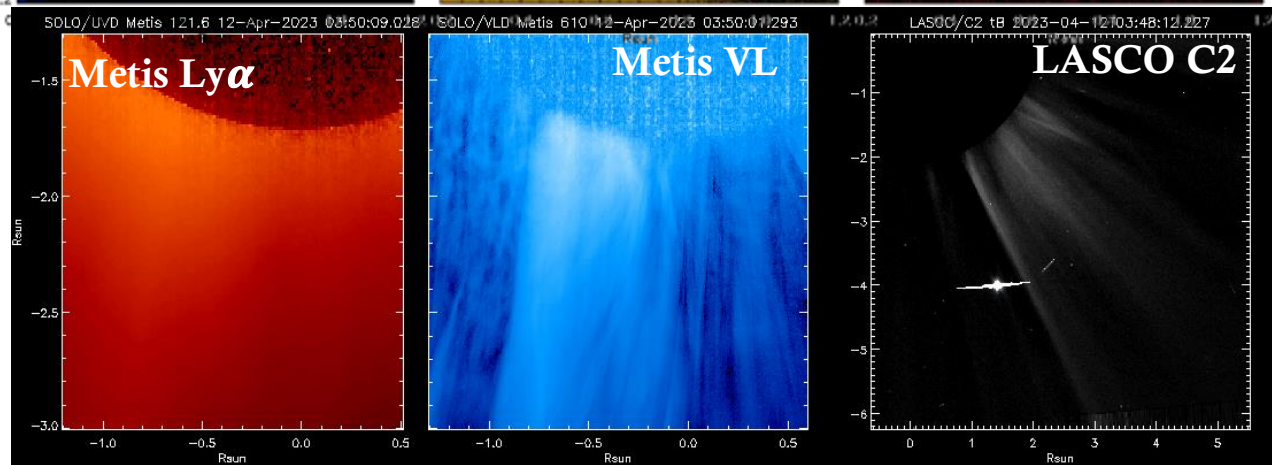
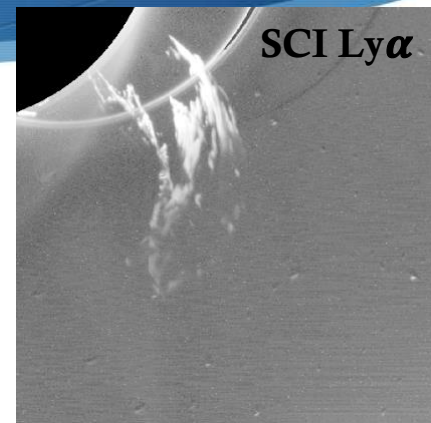
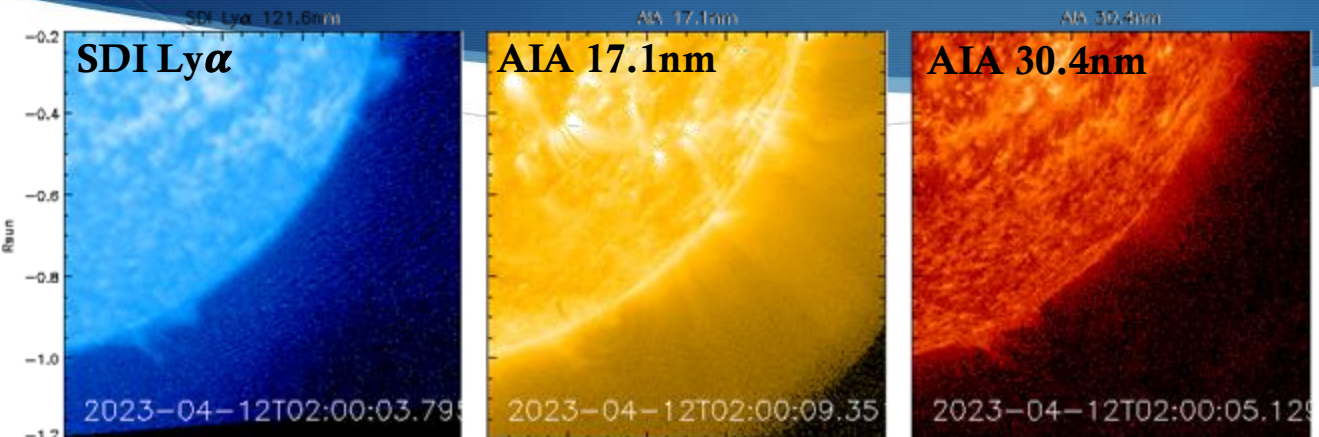
# Coordinated observations: ASO-S/HXI & SoLO/STIX

By Säm Krucker and Yang Su



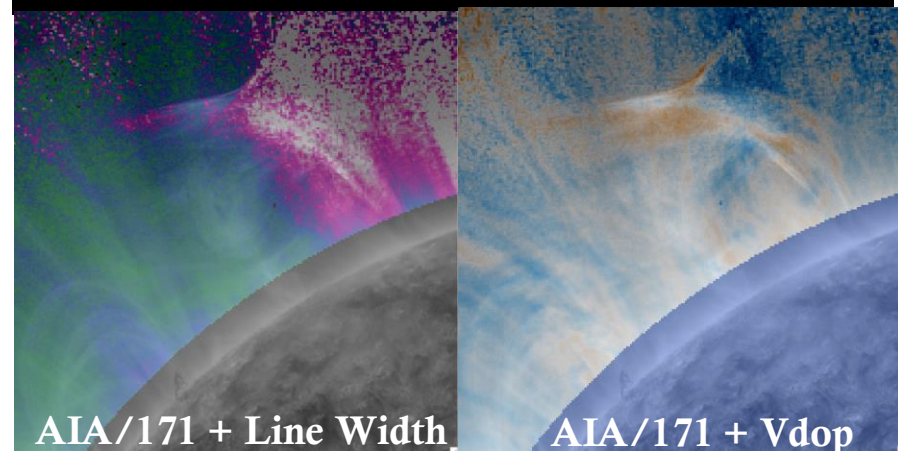
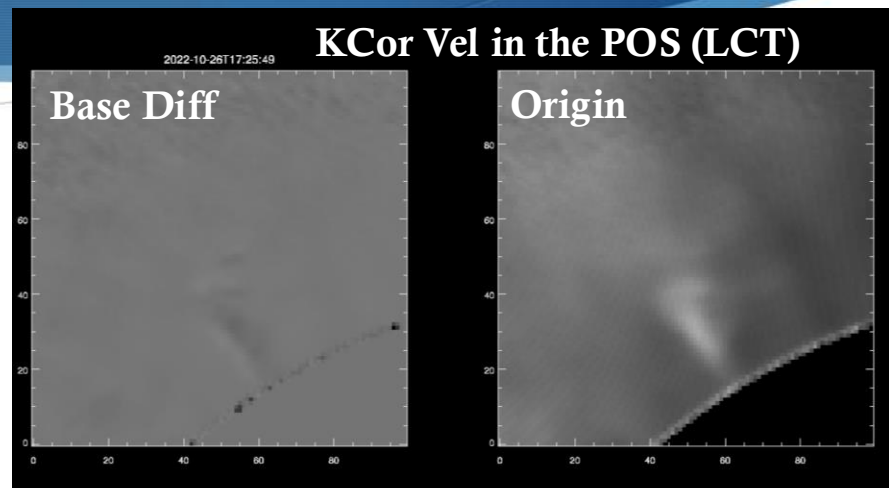
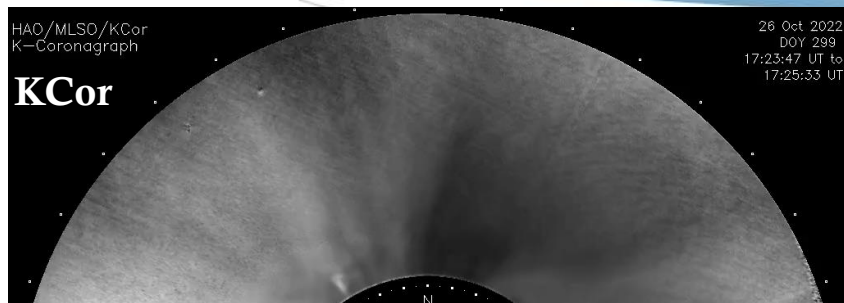
Observations from two different view directions to study the anisotropy of Hard X-ray emission.

# Coordinated observations: ASO-S/LST & SoO/Metis

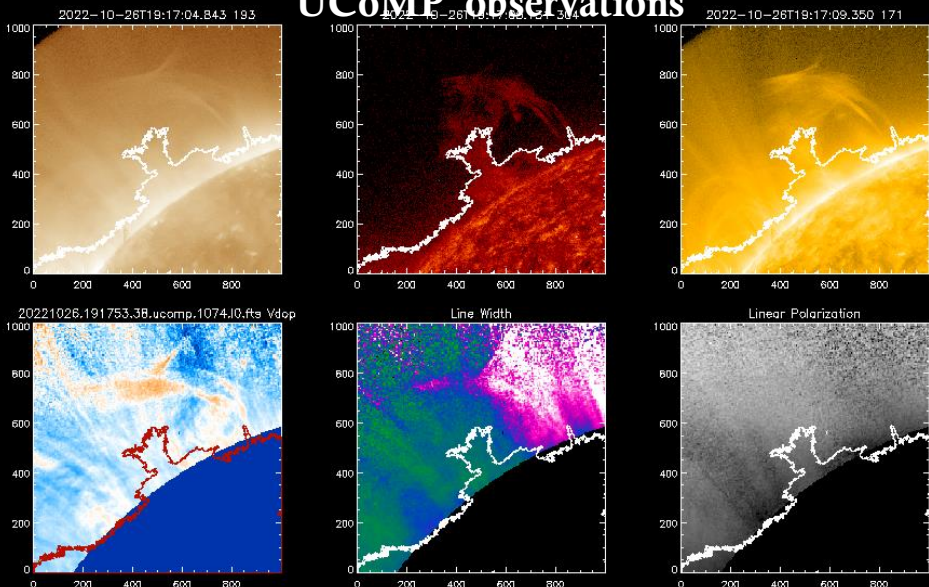


Level 1 data

# Future Coordinated observations: ASO-S/LST & MLSO



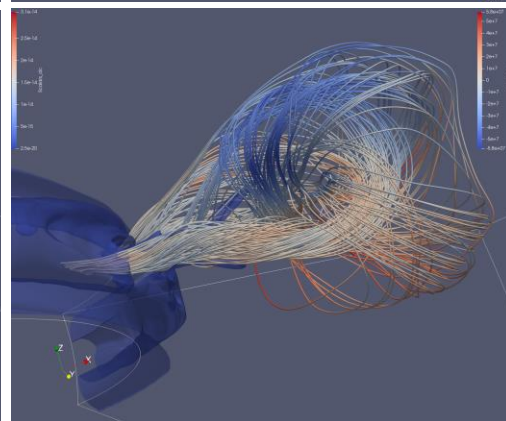
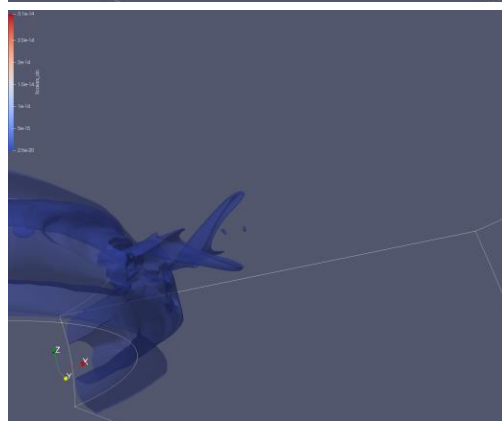
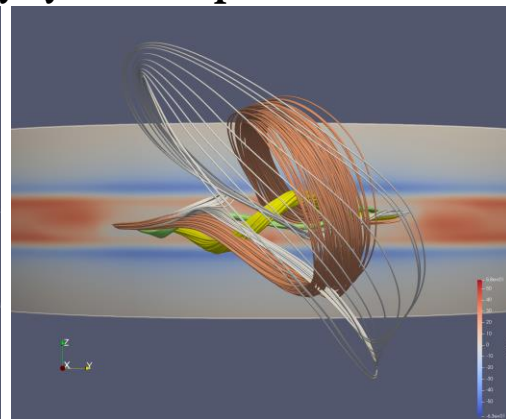
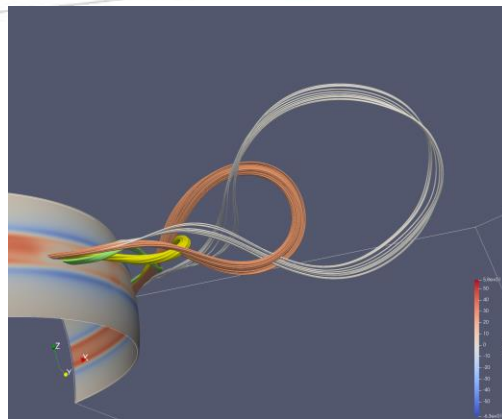
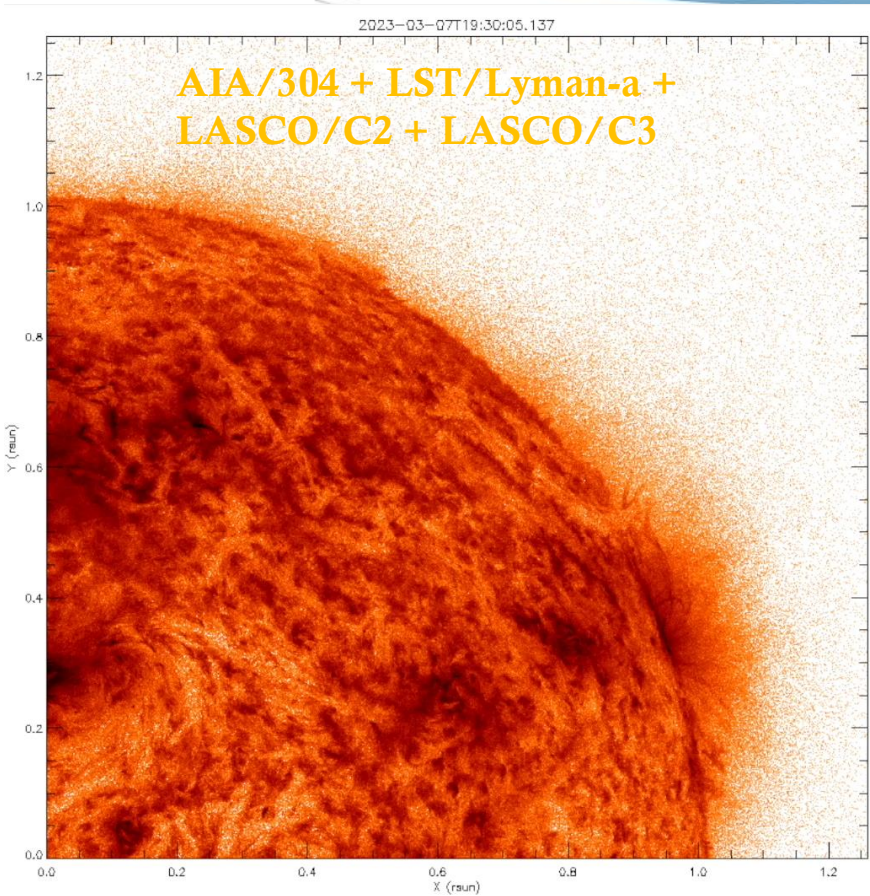
## UCoMP observations



# Future Coordinated observations: ASO-S/LST & PUNCH

Fan, Yuhong & Liu, Tie (2019)

Prominence-cavity system eruption simulation



# Two take-away messages: Guest Investigator Program and Topical Issue in Solar Physics

Collection

## ASO-S Mission: Inflight Performance and First Results

**Submission status**

Closed

The [Advanced Space-based Solar Observatory \(ASO-S\)](#) was launched on October 9, 2022, opening the era of comprehensive solar space observation in China. The mission aims at exploring connections among solar magnetic field, solar flares, and CMEs.

**Editors**



[Weiqun Gan \(甘为群\)](#),



[John Leibacher](#),

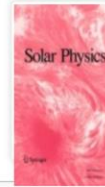


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A special issue collection “**ASO-S Mission: Inflight Performance and First Results**” is online at [Solar Physics](#).

Thank you very much for your attention!

