

第六章

Solar Instruments

程鑫

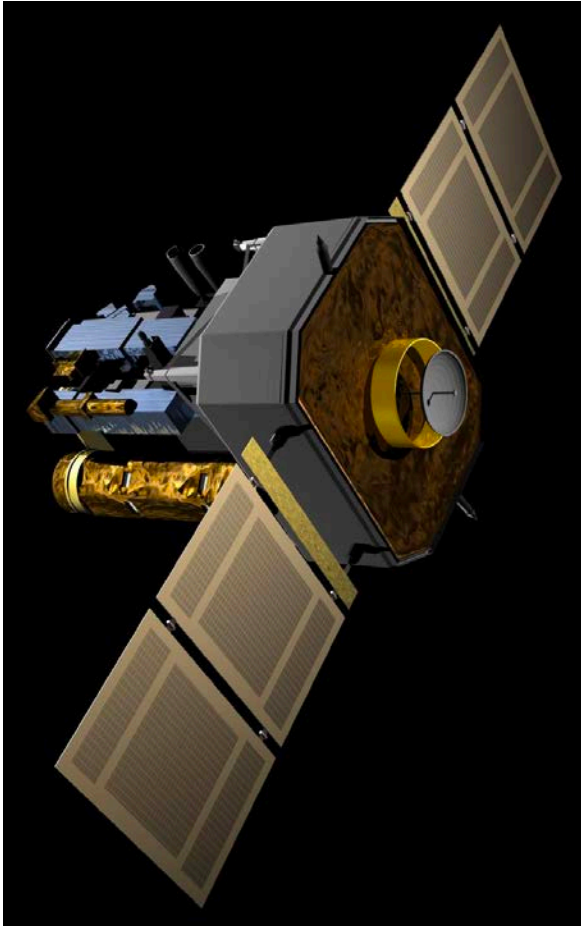
天文楼407

xincheng@nju.edu.cn

太阳观测仪器

- 空间望远镜
- 地面望远镜.

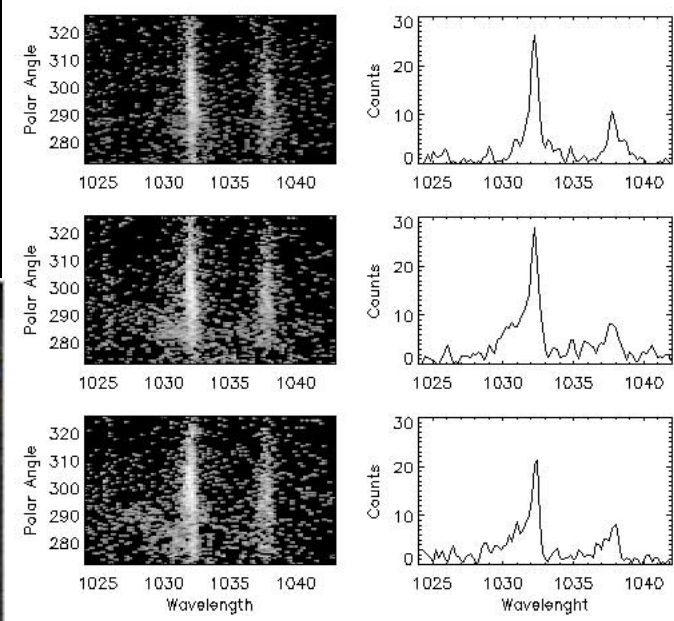
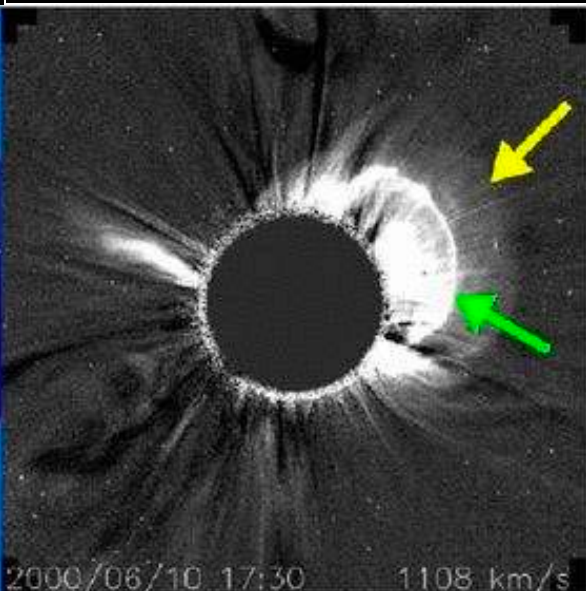
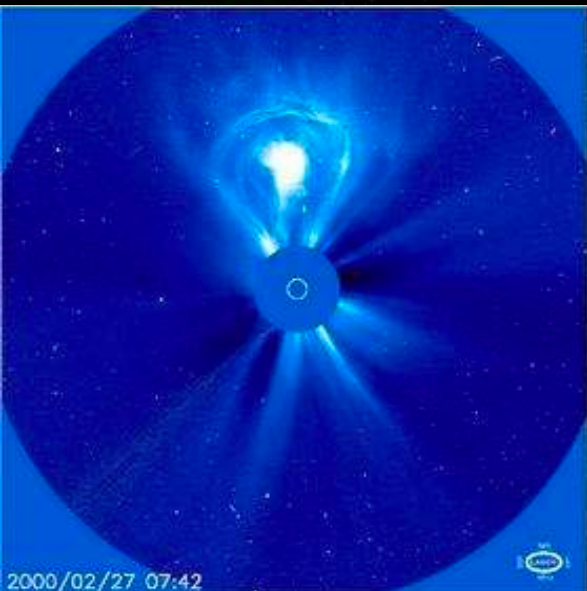
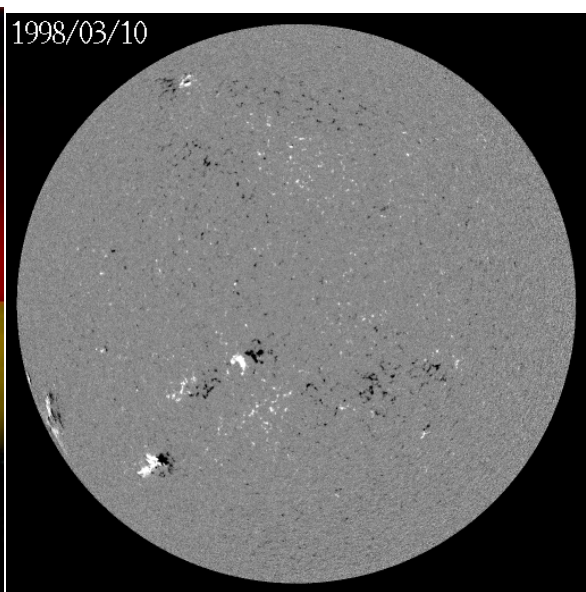
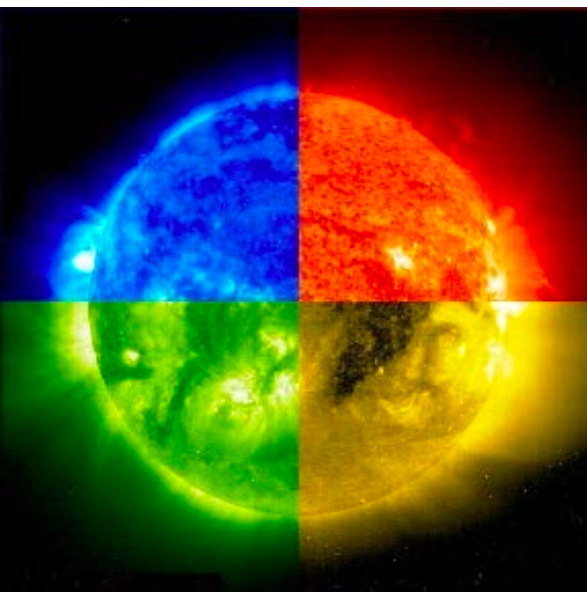
SOHO



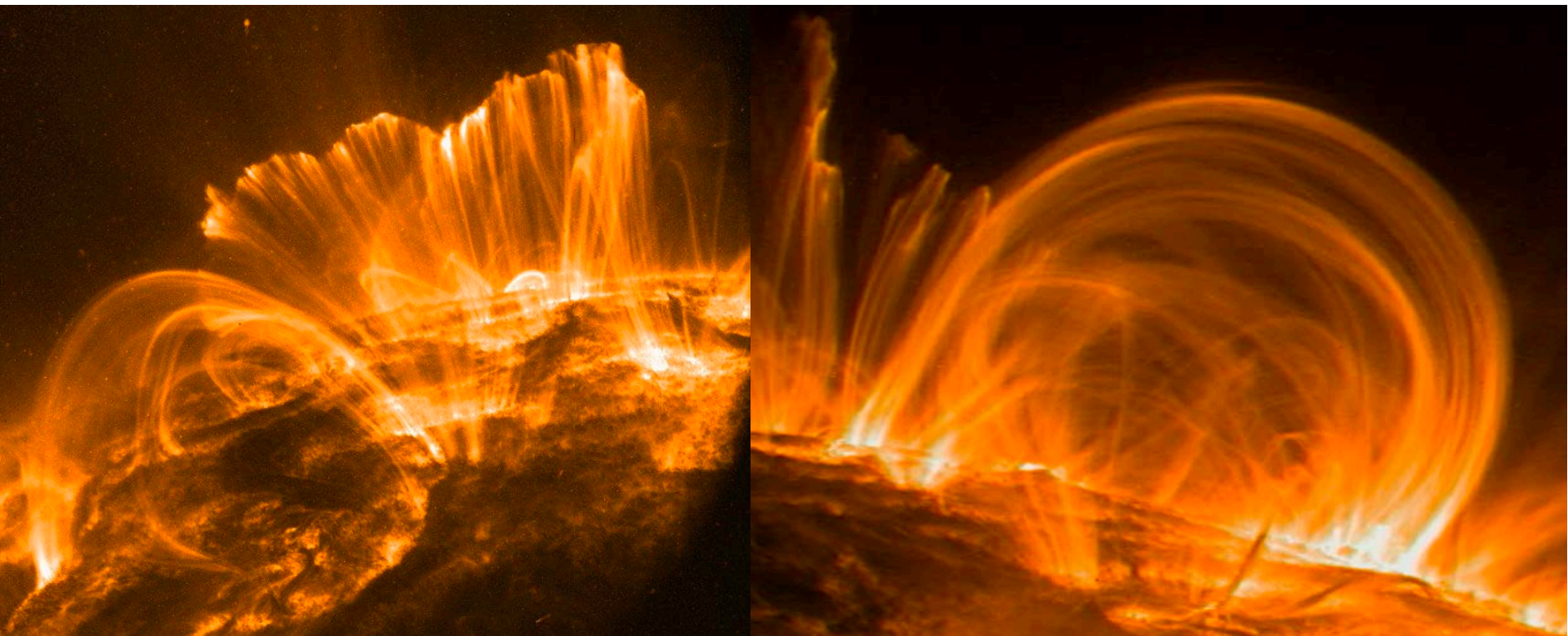
- Dimensions (height, breadth, width): 4.3 x 2.7 x 3.7 m
- Width with solar array deployed: 9.5 m
- Total mass at launch: 1850 kg
- Payload: 610 kg
- Telemetry during real-time operation: 200 Kbits/s
- Telemetry during on-board storage mode: 40 Kbits/s

Main Instruments

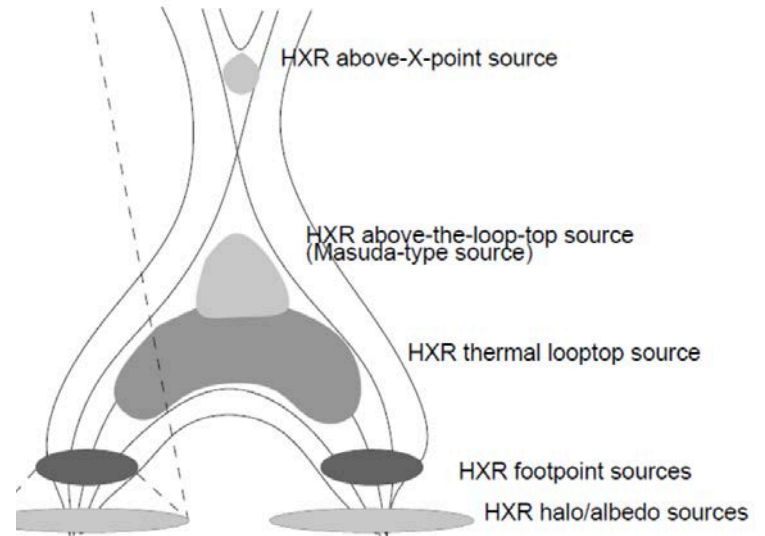
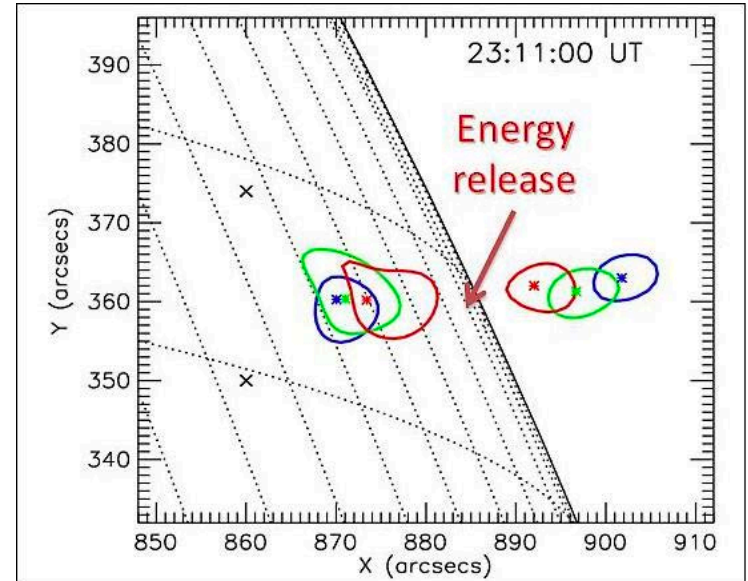
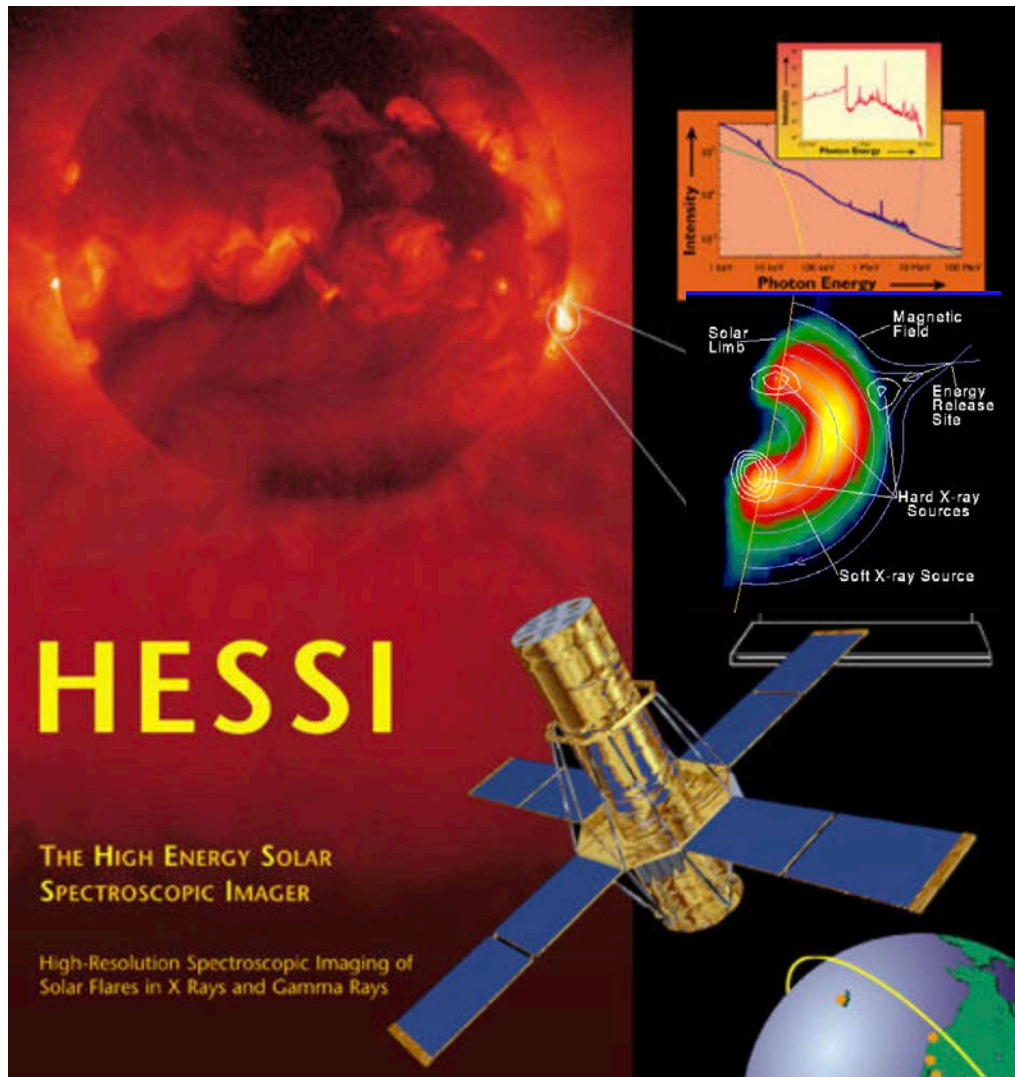
- **CDS** (Coronal Diagnostic Spectrometer)
- [CDS](#) from [Rutherford Appleton Laboratory](#), United Kingdom
- **EIT** (Extreme ultraviolet Imaging Telescope)
- [EIT](#) from the [NASA/Goddard Space Flight Center](#), USA
- **LASCO** (Large Angle and Spectrometric Coronagraph)
- [LASCO](#) from the [Naval Research Laboratory](#), USA
- [LASCO](#) from the [Max Planck Institute for Solar System Research](#), Germany
- **MDI** (Michelson Doppler Imager)
- [MDI](#) from the [Stanford University](#), USA
- **SUMER** (Solar Ultraviolet Measurements of Emitted Radiation)
- [SUMER](#) from the [Max Planck Institute for Solar System Research](#), Germany
- **UVCS** (Ultraviolet Coronagraph Spectrometer)
- [UVCS](#) from the [Harvard-Smithsonian Center for Astrophysics](#), USA



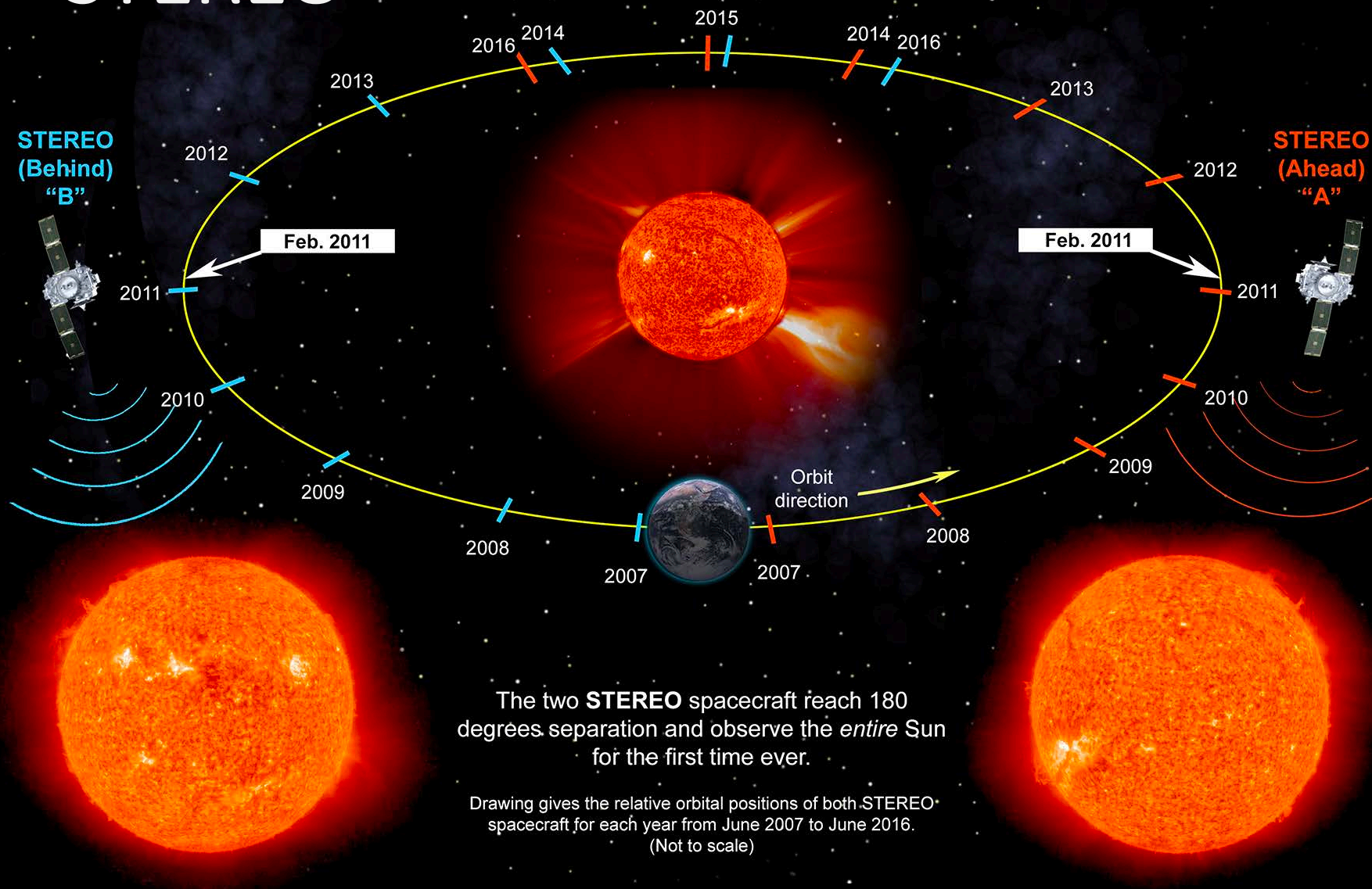
TRACE



RHESSI



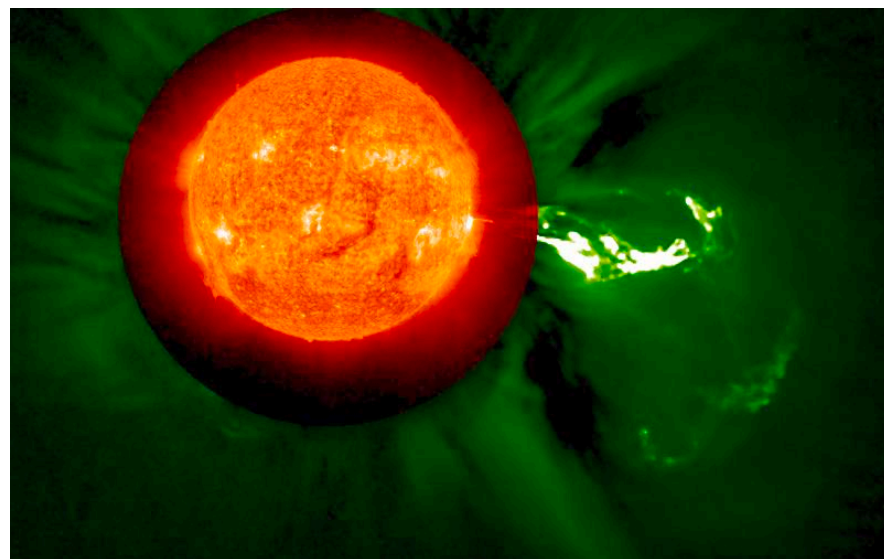
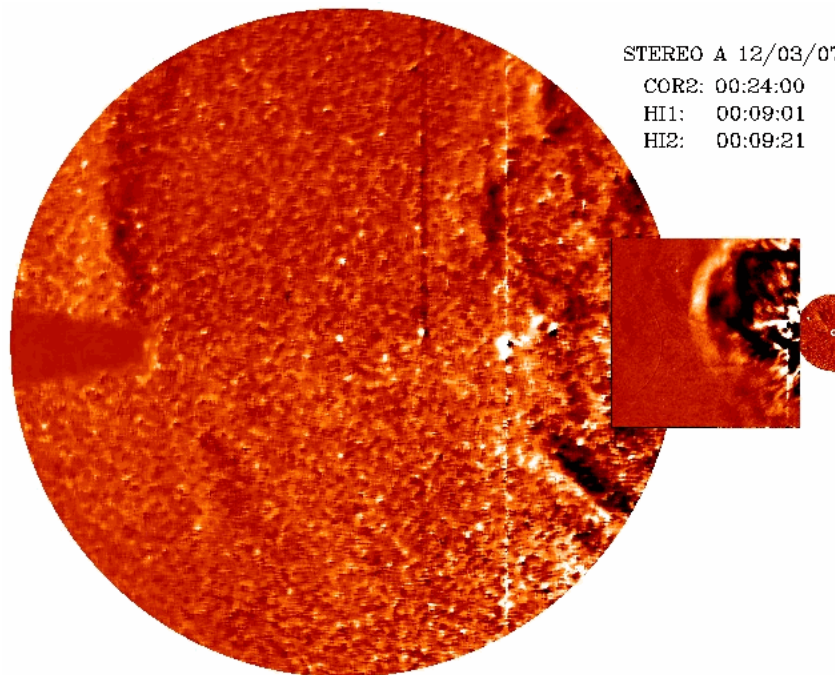
STEREO



STEREO-instruments

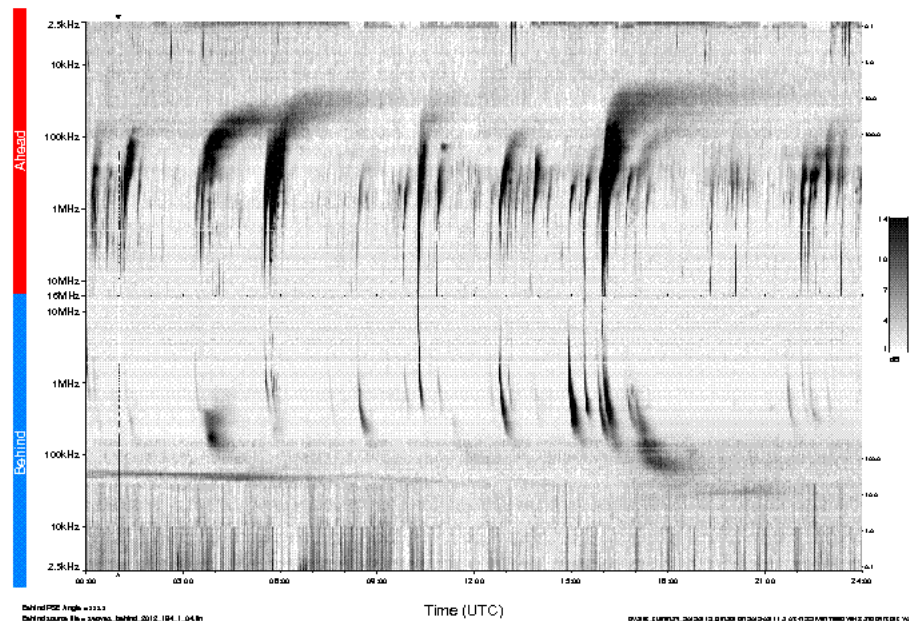
- [SECCHI EUVI: Extreme UltraViolet Imager \(LMSAL\)](#)
- [SECCHI COR1: Inner Coronagraph \(GSFC\)](#)
- [SECCHI COR2: Outer Coronagraph \(NRL\)](#)
- [SECCHI HI: Heliospheric Imager](#)

- [STEREO/WAVES \(SWAVES\)](#)
- [IN-SITU MEASUREMENTS OF PARTICLES AND CME TRANSIENTS \(IMPACT\)](#)
- [PLASMA AND SUPRATHERMAL ION COMPOSITION \(PLASTIC\)](#)

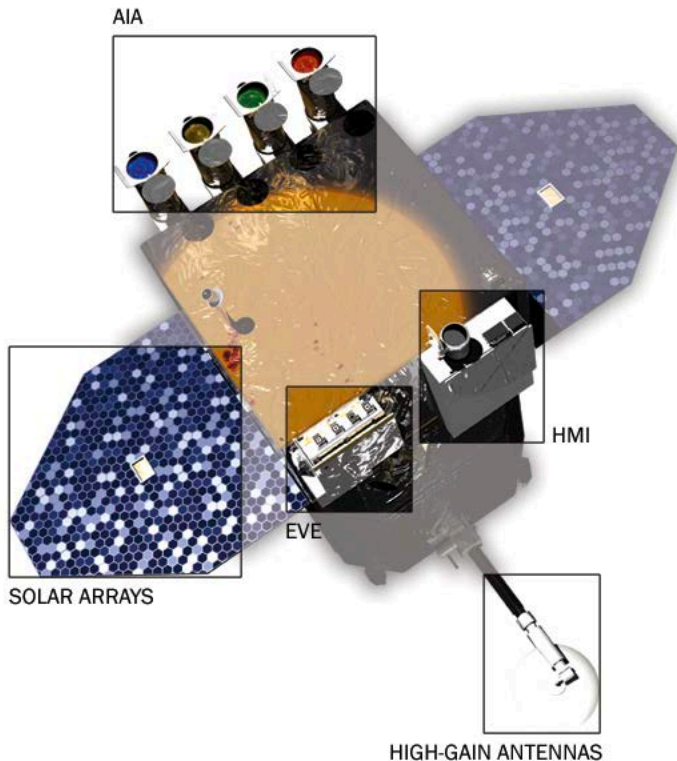


STEREO/WAVES Daily Summary - 12-Jul-2012 (DOY 194)

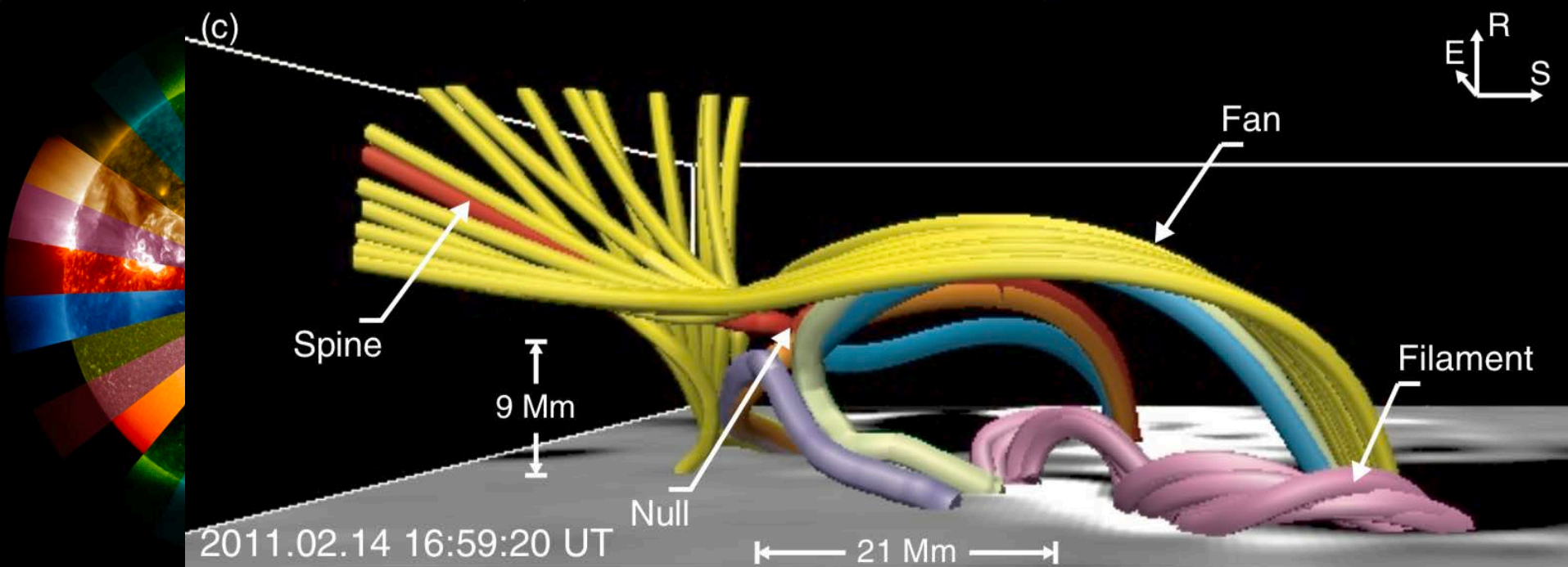
Plot Source File: waves_dsum_2012_194_1_04hr
 Plot PSE Angle = 133.3

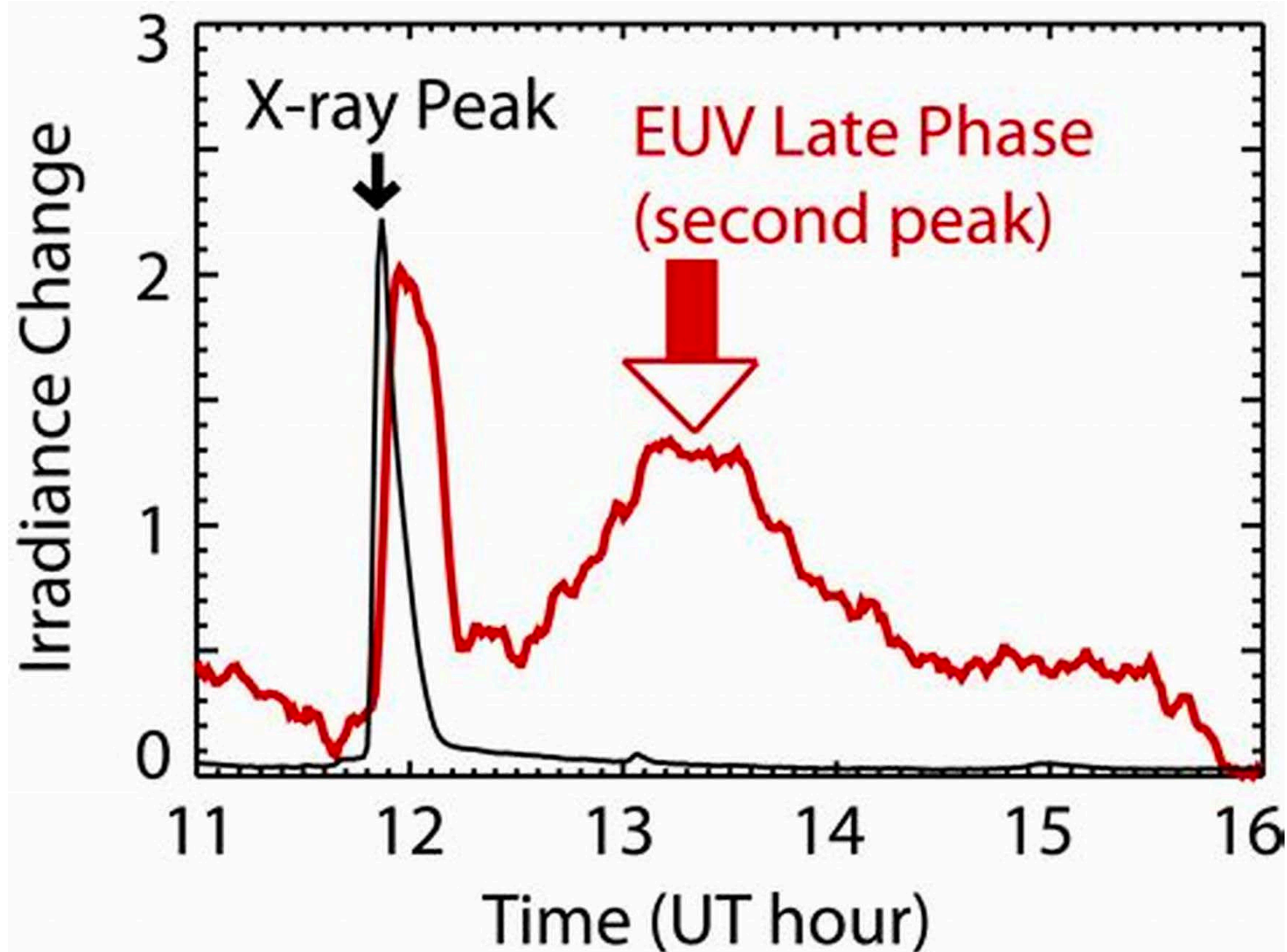


SDO

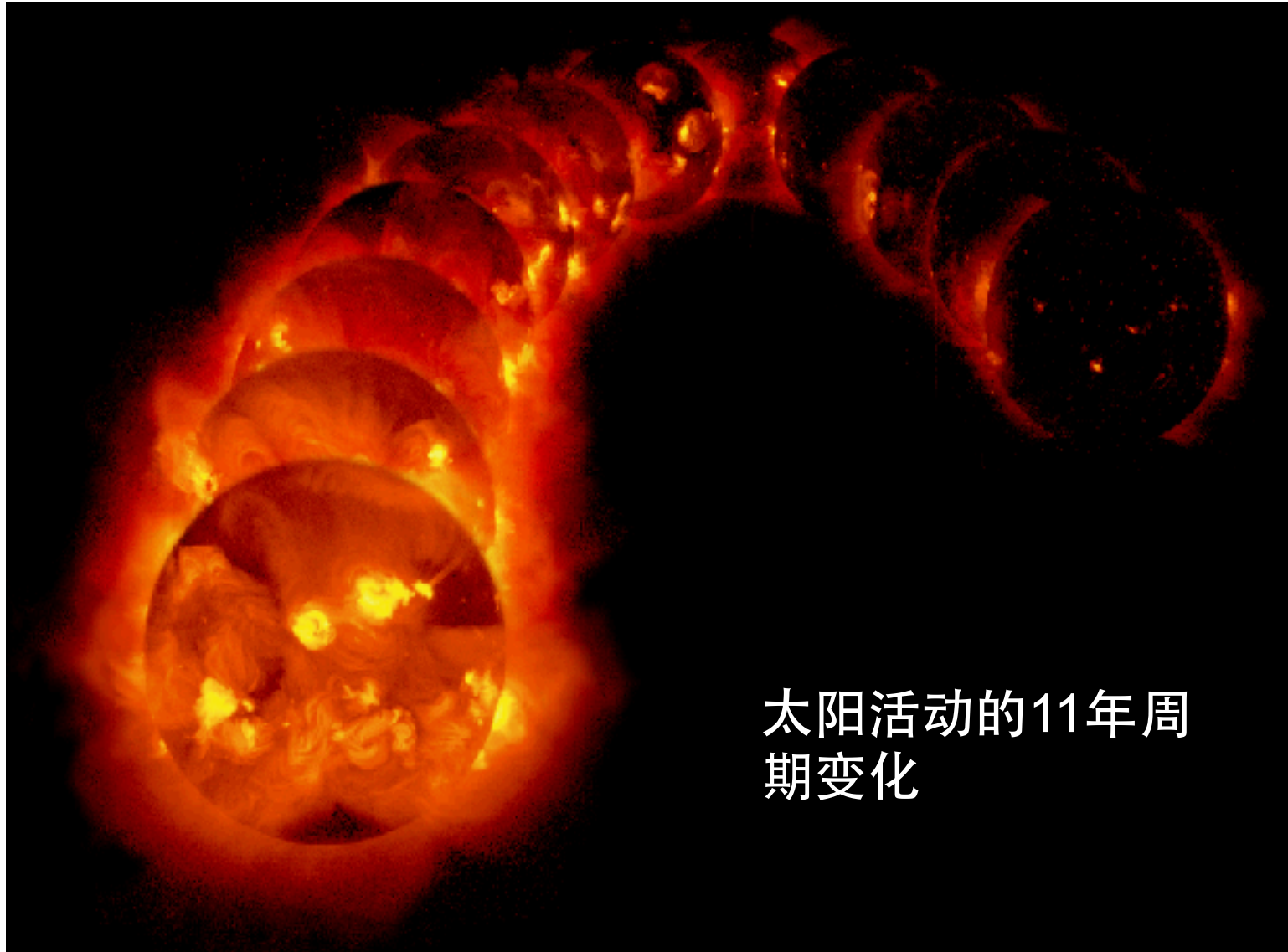


- The total mass of SDO at launch was 3000 kg (6620 lb); instruments 300 kg (660 lb), spacecraft 1300 kg (2870 lb), and fuel 1400 kg (3090 lb).
- Its overall length along the sun-pointing axis is 4.5 m, and each side is 2.22 m.
- The span of the extended solar panels is 6.25 m.
- Total available power is 1500 W from 6.6 m² of solar arrays operating at an efficiency of 16%
- The high-gain antennas rotate once each orbit to follow the Earth.





Yohkoh

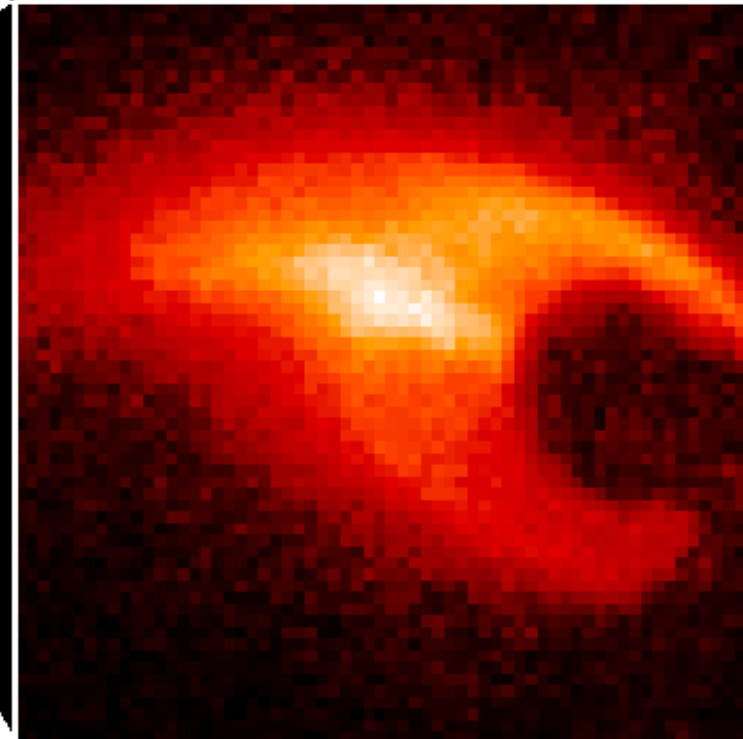


太阳活动的11年周期变化

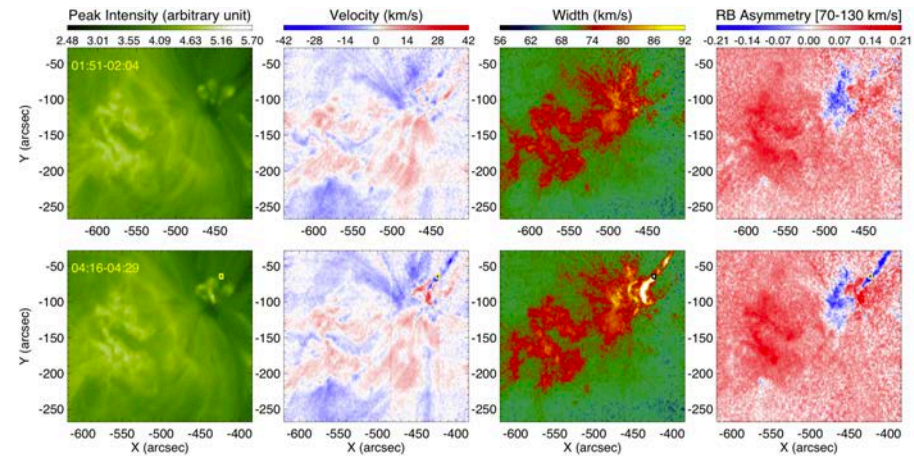
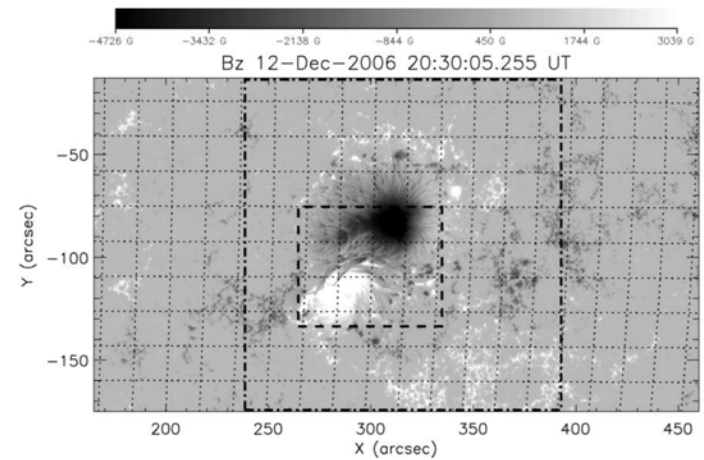
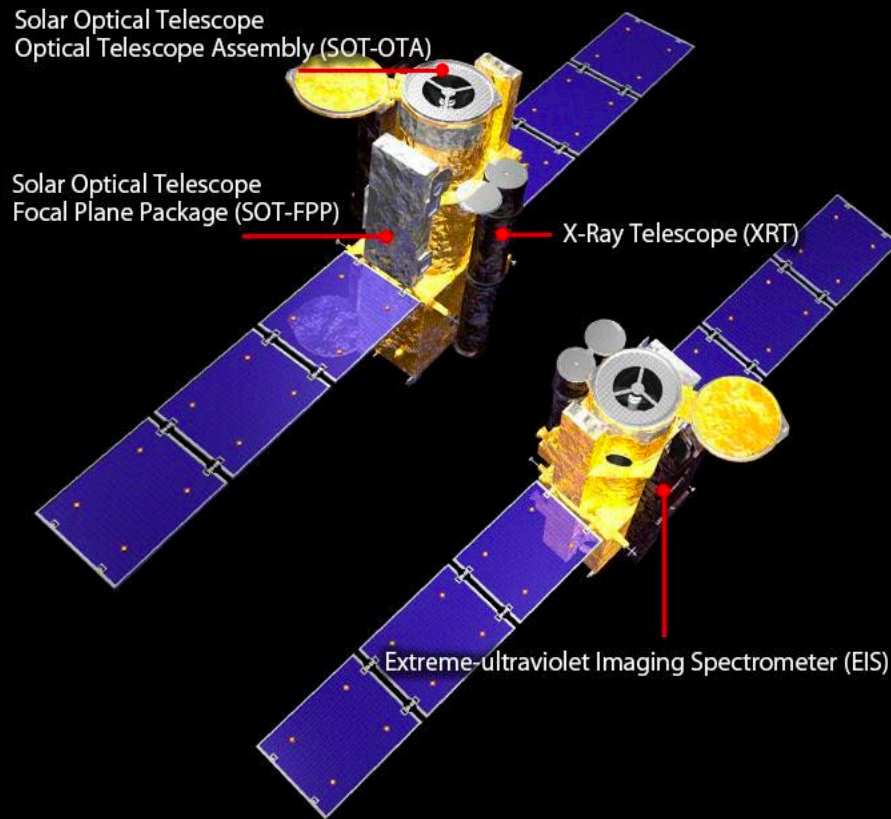
First evidence for reconnection in corona

21-Feb-1992

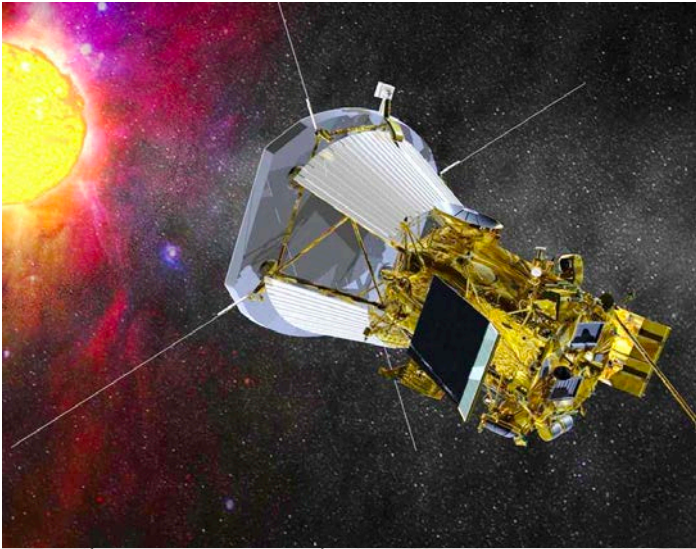
Flare on The East Limb



Solar-B



SPP



- Fields Experiment (FIELDS)

This investigation will make direct measurements of electric and magnetic fields and waves, Poynting flux, absolute plasma density and electron temperature, spacecraft floating potential and density fluctuations, and radio emissions.

- Integrated Science Investigation of the sun (IS $\odot$ IS)

This investigation makes observations of energetic electrons, protons and heavy ions that are accelerated to high energies (10s of keV to 100 MeV) in the sun's atmosphere and inner heliosphere, and correlates them with solar wind and coronal structures.

- Wide-field Imager for Solar PRobe (WISPR)

These telescopes will take images of the solar corona and inner heliosphere. The experiment will also provide images of the solar wind, shocks and other structures as they approach and pass the spacecraft. This investigation complements the other instruments on the spacecraft providing direct measurements by imaging the plasma the other instruments sample.

- Solar Wind Electrons Alphas and Protons (SWEAP) Investigation

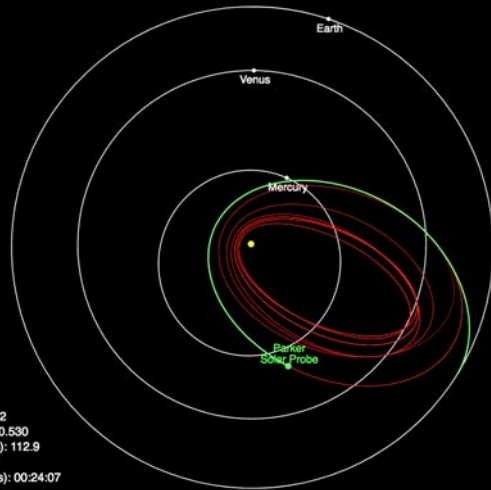
This investigation will count the most abundant particles in the solar wind -- electrons, protons and helium ions -- and measure their properties such as velocity, density, and temperature.

科学目标

1. **Trace the flow of energy that heats the solar corona and accelerates the solar wind.**
 - 1a. How is energy from the lower solar atmosphere transferred to, and dissipated in, the corona and solar wind?
 - 1b. What processes shape the non-equilibrium velocity distributions observed throughout the heliosphere?
 - 1c. How do the processes in the corona affect the properties of the solar wind in the heliosphere?
2. **Determine the structure and dynamics of the plasma and magnetic fields at the sources of the solar wind.**
 - 2a. How does the magnetic field in the solar wind source regions connect to the photosphere and the heliosphere?
 - 2b. Are the sources of the solar wind steady or intermittent?
 - 2c. How do the observed structures in the corona evolve into the solar wind?
3. **Explore mechanisms that accelerate and transport energetic particles.**
 - 3a. What are the roles of shocks, reconnection, waves, and turbulence in the acceleration of energetic particles?
 - 3b. What are the source populations and physical conditions necessary for energetic particle acceleration?
 - 3c. How are energetic particles transported in the corona and heliosphere?

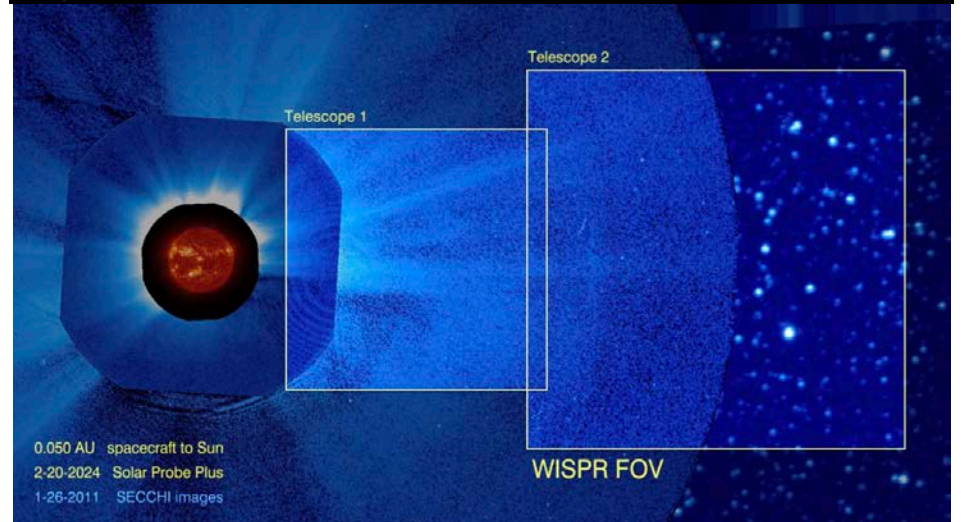
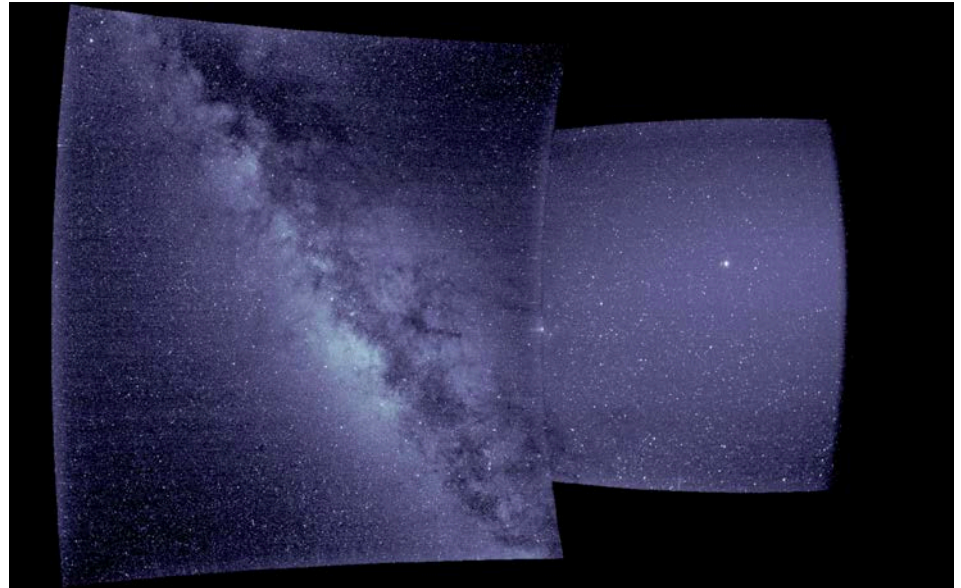
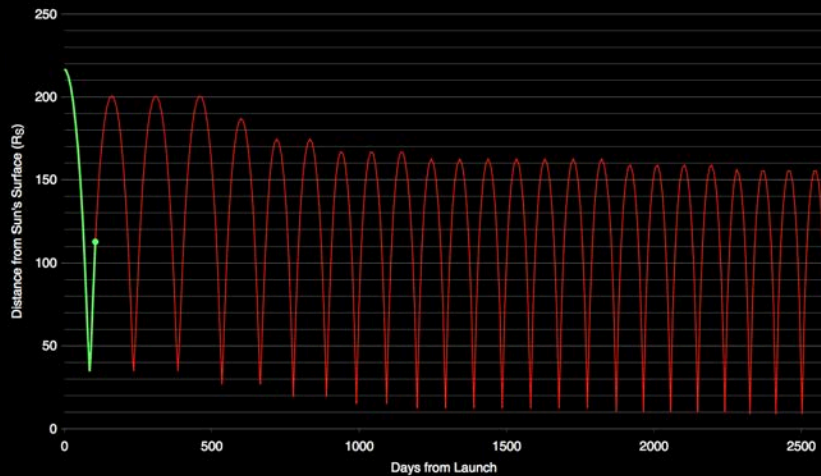
Orbit and First light

Parker Solar Probe Mission Trajectory and Current Position



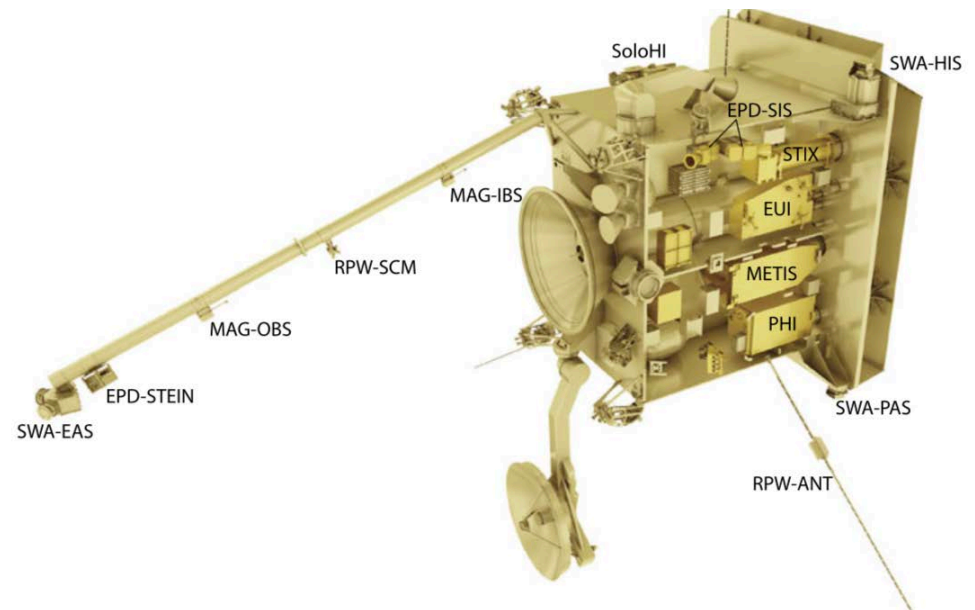
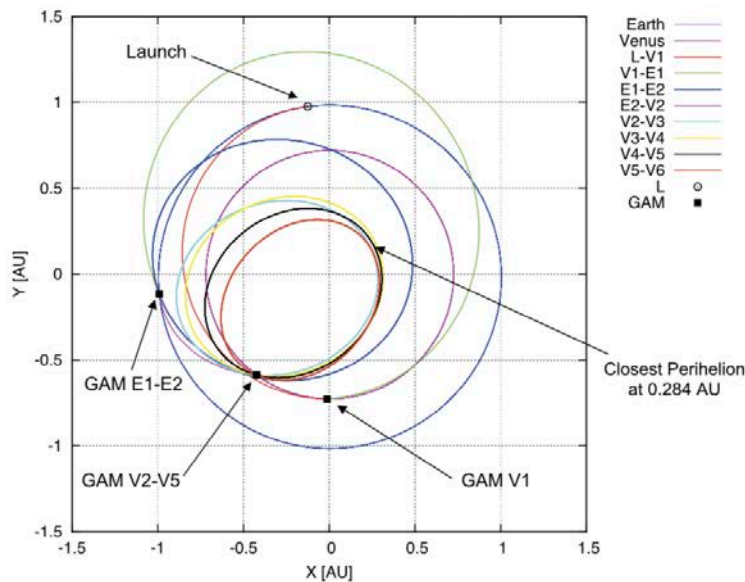
Heliocentric Velocity (km/s): 41.72
Distance from Sun Center (AU): 0.530
Distance from Sun's Surface (R_S): 112.9
Distance from Earth (AU): 1.450
Round-Trip Light Time (hh:mm:ss): 00:24:07
25 Nov 2018 14:00:00 UTC

Parker Solar Probe Distance from Sun



Solar Orbiters

- What drives the solar wind and where does the coronal magnetic field originate from?
- How do solar transients drive heliospheric variability?
- How do solar eruptions produce energetic particle radiation that fills the heliosphere?
- How does the solar dynamo work and drive connections between the Sun and the heliosphere?



ASO-S

全日面矢量磁像仪(FMG)

全日面矢量磁像仪(FMG)用于开展太阳光球矢量磁场的成像观测。全日面矢量磁像仪由成像光学系统、偏振光学系统、数据采集与处理系统三大功能块组成。其望远镜采用口径140mm的远心光路设计；探测器采用 $4K \times 4K$ 像元、帧频16 fps的CMOS相机；偏振光学系统由经典的里奥(Lyot)型双折射滤光器和液晶型偏振分析器系统组成，滤光器工作波长532.4 nm，带宽(FWHM)为0.01 nm。

为了获得足够高的测量精度，拟采用“深积分”观测方式提高灵敏度，在常规观测模式下，单磁场分量观测由 256×2 帧图像完成，一组矢量磁图用时2分钟，纵向分量灵敏度5G，横向分量精度150G。在一个分量观测中要求图像稳定度优于0.25角秒，但由于卫星平台无法满足这一图像稳定度要求，全日面矢量磁像仪将自带稳像系统

全日面矢量磁像仪基于双折射滤光器而成。由于斯托克斯(Stokes)参数仪不能实时成像，采用类似于Hinode/SP的观测系统对于太阳活动现象的跟踪和预报研究是非常不利的，相比较而言，全日面矢量磁像仪具有更高的观测效率和时间分辨率，更契合先进天基太阳天文台的科学需求。而相较于SDO/HMI和SOHO/MDI，全日面矢量磁像仪设备相对简化，观测模式简单，磁场测量精度更高。

莱曼阿尔法太阳望远镜(LST)

莱曼阿尔法太阳望远镜包含三台仪器，即一台口径60毫米莱曼阿尔法全日面成像仪(SDI)、一台口径60毫米的日冕仪(SCI)、一台口径80毫米兼做导行镜的白光望远镜(WST)和一个30毫米口径的导行镜(GT)。

莱曼阿尔法全日面成像仪在莱曼阿尔法波段($121.6 \pm 7.5\text{nm}$)以4-60秒的时间间隔对太阳从日面中心到1.2个太阳半径进行成像观测。莱曼阿尔法全日面成像仪使用 4096×4096 像元的探测器以获得0.56角秒的像元分辨率。莱曼阿尔法全日面成像仪的结构类似于中法太阳爆发探测小卫星(SMESE)中的全日面成像仪(LADI)，但口径更大。同时，莱曼阿尔法全日面成像仪和日冕仪都将通过压电陶瓷驱动稳像系统来实现太阳的稳定以满足高分辨率成像观测的要求。

日冕仪使用 2048×2048 像元的探测器对1.1-2.5个太阳半径的内日冕以3-120秒的时间间隔在莱曼阿尔法波段($121.6 \pm 10\text{nm}$)进行成像观测并白光波段($700 \pm 20\text{nm}$)进行偏振亮度观测。在日冕仪光路中加入分光镜，将入射的日冕光分成透射和反射两部分。反射部分经过莱曼阿尔法滤光片后成像在莱曼阿尔法波段探测器；透射部分在经过宽带滤光片、线偏振片后成像在白光波段探测器上，在 0° 及 60° 三个方向进行日冕偏振亮度测量。

白光望远镜采用 4096×4096 像元的CMOS探测器在通常模式下以3-60秒的时间间隔对太阳从日面中心到1.2个太阳半径进行紫外连续谱($360 \pm 2.0\text{nm}$)成像观测，在快速的爆发事件模式下通过开窗输出的方式使用时间间隔小于0.2秒。白光望远镜的成像观测的空间分辨率与莱曼阿尔法全日面成像仪相同。

导行镜工作波段为 $675.8 \pm 5\text{nm}$ ，通过四象限光电二极管对太阳边缘进行探测，实时计算太阳边缘的偏移量并将偏移量转化成导行信号。导行信号最终转化成驱动信号驱动安装在莱曼阿尔法全日面成像仪和日冕仪主镜后面的压电陶瓷晶体实现太阳的稳定。

太阳硬X射线成像仪(HXI)

太阳硬X射线成像仪在30-200 keV的高能段以优于0.5秒的时间分辨率对全日面进行高时间分辨率成像观测。太阳硬X射线成像仪的视场达到1度(从日面中心到1.875太阳半径)，能量分辨率在30keV和1467keV分别为27%和5.6%，在30 keV的角分辨率为6角秒。太阳硬X射线成像仪的设计以太阳耀斑为主要观测目标。太阳硬X射线成像仪采用与日本阳光(YOHKOH)卫星上的硬X射线望远镜(HXT)和太阳轨道探测器(Solar Orbiter)上X射线成像光谱望远镜(STIX)相同的空间调制间接成像技术。这不同于Reuven Ramaty太阳高能光谱成像(RHESSI)所用的旋转调制间接成像技术。太阳硬X射线成像仪自带导行望远镜，它在白光波段对太阳进行监视并提供太阳硬X射线成像仪的定位信息。同时，它还可以提供太阳爆发的位置信息。

Big Bear

Broad-Band Filter Imager—BFI

G-band (430.5 nm, 5-Å bandpass) with a field of view of 55" and 0.027"/pixel image scale, red continuum (668.4 nm, 4-Å bandpass) and TiO (705.7 nm, 10-Å bandpass) with a field of view of 70" at 0.034"/pixel image scale.

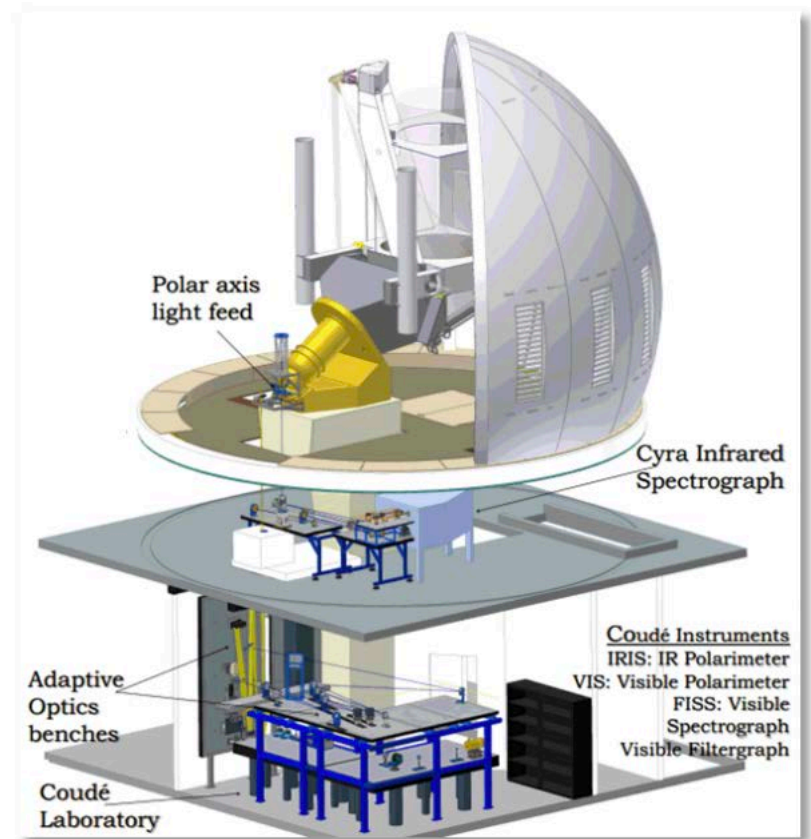
Visible Imaging Spectrometer—VIS

Available spectral lines include H-alpha, Fe I 630 nm, and Na I D2 (589 nm).

Near Infra-Red Imaging Spectropolarimeter—NIRIS

The primary lines used by NIRIS are the Fe I 1565 nm doublet, and the He I 1083 nm multiplet. The Fe I bandpass is 0.1 Å while the He I bandpass is 0.05 Å.

Fast-Imaging Solar Spectrograph—FISS



NVST

1. Multi-Channel High Resolution Imaging System

Channels	TiO-band	G-band	H-alpha
Center wave. (Angstrom) :	7058	4300	6562.8 $\pm$ 5 tunable
Bandpass (Angstrom):	10	8	0.25
Focal length (meter):	35 (26)	35	22.5
frames/sec (fps)	10	10	10
Field of View (arc sec)	180*180	180*180	180*180

2. Vertical spectrometers

3. Adaptive optical system



ASO-G

筹划中.....

