China's Activities in Solar and Space Physics

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Outline

- Ground Observations
- Main scientific themes
- MIT
- SPORT
- ASO-S
- DSO and KUAFU
- Lunar program
- International cooperation

Chinese Meridian Project

It is a Chinese multi-station chain mainly along 120ºE to monitor geospace environment, starting from Mohe, the northernmost city in China, through Beijing、 Wuhan、 Guangzhou and extended to Chinese Zhongshan station in the Antarctic.

Operation Kick-off on October 2012

15 stations, 38 observing sites and 94 instruments: after 58 months of construction, one of the world's most extensive ground-based system for geospace weather monitoring passed the national review for acceptance in Beijing on October 23, 2012 to officially start data collection and scientific research.

Station Distribution

- Geomagnetic
- Optical-atoms.
- Radio
- Rocket


DIM


OFM


FGM


SCM


SED


DEM


ASAI


FPI


LIDA


AURO


CRM


TEL IPS


DPS IONO


DOPP TEC


METR


HFR


MST

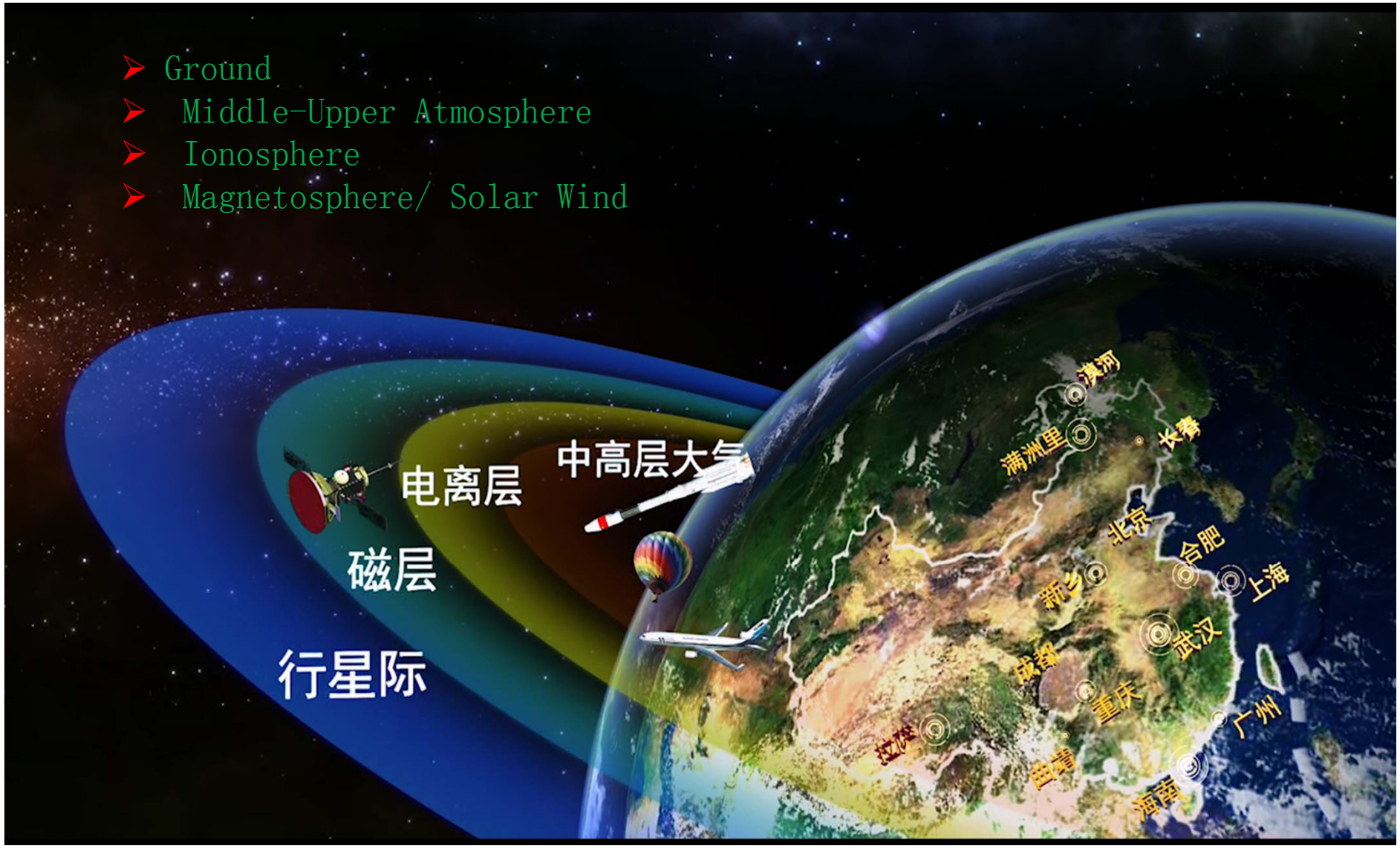

VHF


ISR


SROC MROC

Key Parameters

- Ground
- Middle-Upper Atmosphere
- Ionosphere
- Magnetosphere/ Solar Wind



Status of MP

- Chinese Meridian Project is in full operation.
- Up to July, 2014, it has collected 2.4 TB of scientific data for 64 space environment key parameters.
- More than 150 peer – reviewed paper have been published, with them 8 are published in JGR in 2014.
- Observation chain is now extending to the north into Russia and south to south asia and Australia
- To the west sphere of the global in Canada, US, Brazil, Chile and Argentina – forming a **International Meridian Circle**

International Space Weather Meridian Circle Program (IMCP)

To connect 120ºE and 60ºW meridian chains of ground based monitors worldwide, in order to provide a global picture of unfolding space weather events.

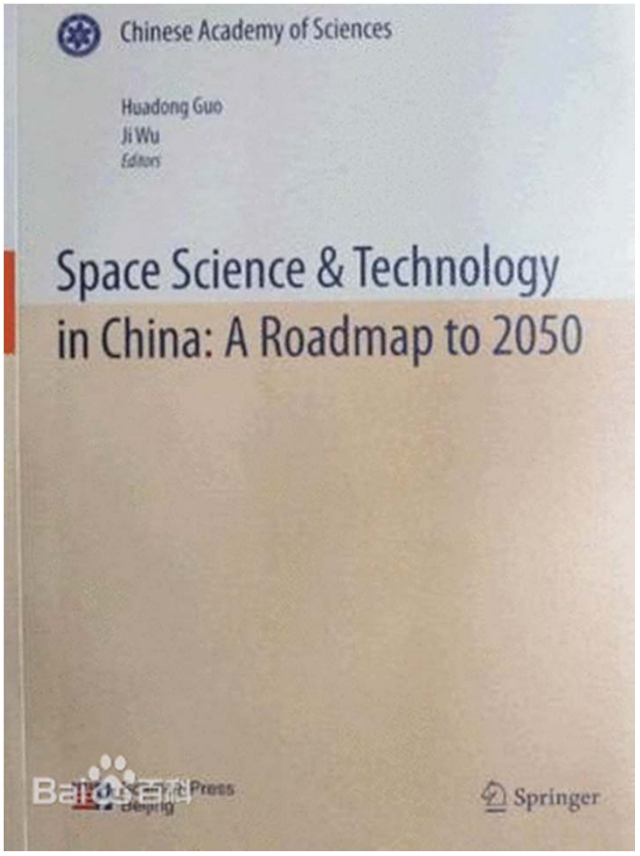
Status of IMCP

- The Ministry of the Science and Technology (MOST) has given a fund to start the Program in (2013), followed with fund from CAS in 2013 too.
- From 2013-2015, discussions and even MoU's have been signed between NSSC and institutes from Canada, US, Russia, Brazil, Australia, etc..
- The Headquarters and data centers of IMCP are now established in Beijing, a few organized measurement campaigns have been conducted already globally during several solar event.

Two Themes of Space Science Towards 2050

Theme 1. How did matter originate (universe and life), how does it evolve and move?

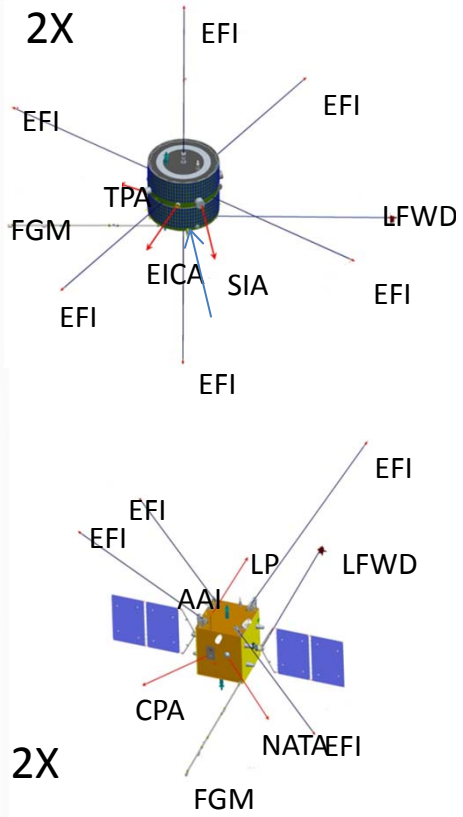
Theme 2. What is the relationship between solar system and human beings?



Magnetosphere- Ionosphere-Thermosphere Coupling Exploration Mission (MIT)

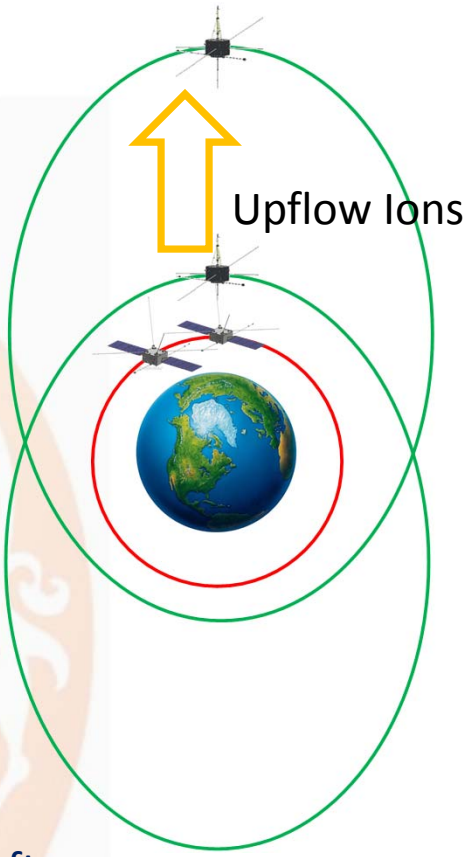
Scientific Objectives：

- ✓ Investigate the origin of the outflow ions and their acceleration mechanisms
- ✓ Understand the impact of the outflows ions on dynamic processes in the magnetic sphere, including magnetic storm development
- ✓ Characterize the ionosphere and thermosphere storm driven by magnetic storms
- ✓ Discover the key mechanism for the magnetosphere, ionosphere and thermosphere coupling



Period_MA/ Period_ITA=9:1

Spacecraft	ITA	ITB	MA	MB
inclination	90°	90°	90°	90°
perigee	500 km	500 km	1 Re	1 Re
apogee	1500 km	1500 km	7 Re	7Re



Magnetosphere Spacecraft

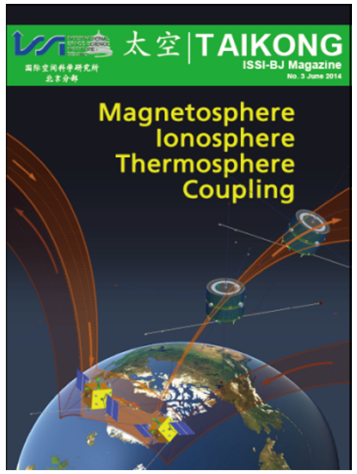
- TPA: Thermal Plasma Analyzer
- SIA: Suprathermal Ion Analyzer
- EICA: Energetic Ion Composition Analyzer
- EFI : Electric Field Instrument
- FGM: Fluxgate Magnetometer
- LFWD: Low Frequency Wideband Detector
- NAIS: Neutral Atom Imaging System

Ionosphere Spacecraft

- AAI: Airglow Aurora Imager
- NATA: Neutral ATmosphere Analyzer
- CPA: Cold Plasma Analyzer
- LP: Langmuir Probe

Status of MIT

- Concept Study was supported by CNSA in 2009-2010
- Feasibility study has been supported by CAS (2011-2015)
- MIT Forum was successfully held at ISSI-Beijing on October 31 – November 1, 2013. More than 40 scientists from USA, Canada, UK, Germany, Romania and China attended the forum.
- The mid-term external evaluation organized by CAS about the feasibility study on MIT was carried out in April, 2014.
- Participation of a selection for pre-phase B design in Feb. 2015, the result will be released soon. If approved, the launch date will be in 2019.



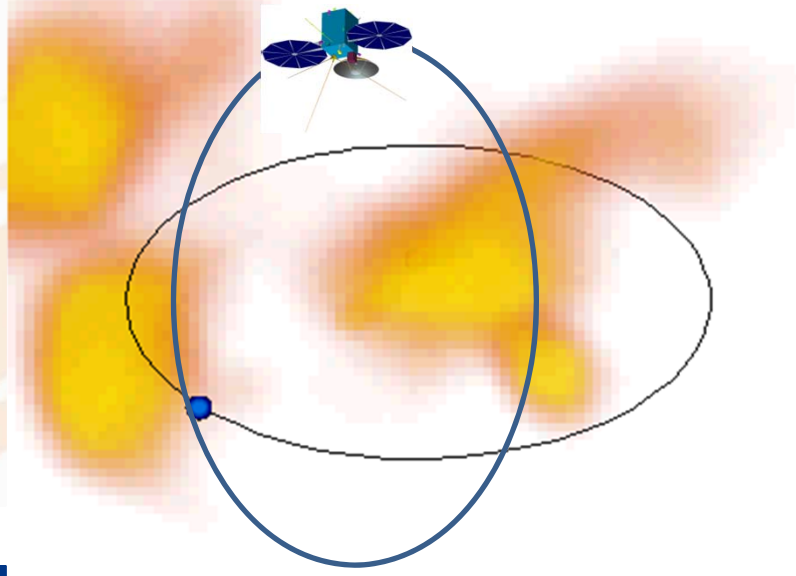
Solar Polar ORbit Telescope (SPORT)

➢Science Objectives:

SPORT will be the first mission to image the propagation of CME continuously off the ecliptic plane.

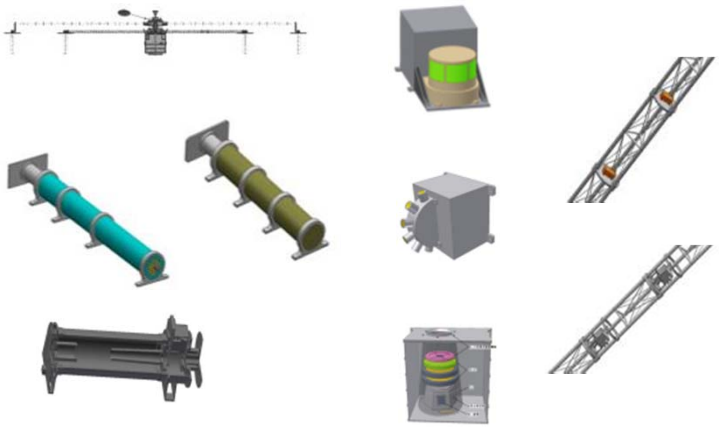
- ✓Imaging & tracking interplanetary CMEs propagation
- ✓Observation on solar high latitude

Orbit realization	solar polar orbit (with the gravity assist of Jupiter)
Inclination	>60 °
perihelion	0.7AU
aphelion	5 -> 3 -> 2 AU



CASS/UCSD 2002/07/26 00

Scientific Payload



CME and ICME imaging	1	Synthetic aperture radio imager
	2	Heliospheric imager
	3	Large angle coronagraph
Solar Imaging	4	Solar magnetograph
	5	Solar ultraviolet imager (121.6nm)
Particle detectors	6	High energy particle detector
	7	Heavy ion composition detector
	8	Solar wind plasma detector
Wave detectors	9	Fluxgate magnetometer
	10	Low frequency electromagnetic wave detector
	11	Solar radio burst detector

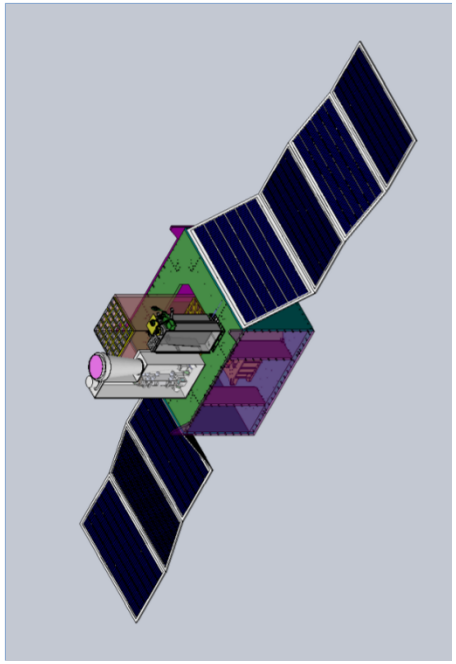
Status of SPORT

- Concept Study was supported by CNSA in 2009-2010
- Feasibility-study has been supported by CAS (2011-2015)
- The Forum on the Solar Polar Orbit Telescope (SPORT) was held at ISSI-BJ on November 24-25, 2013. A total of 30 leading scientists from 7 countries participated in this Forum.
- The mid-term evaluation organized by CAS was carried out in April, 2014.
- SPORT will participate the next round of selection next year for a possible launch date of 2012.

Advance Solar Observatory in Space (ASO-S)

Scientific Objectives

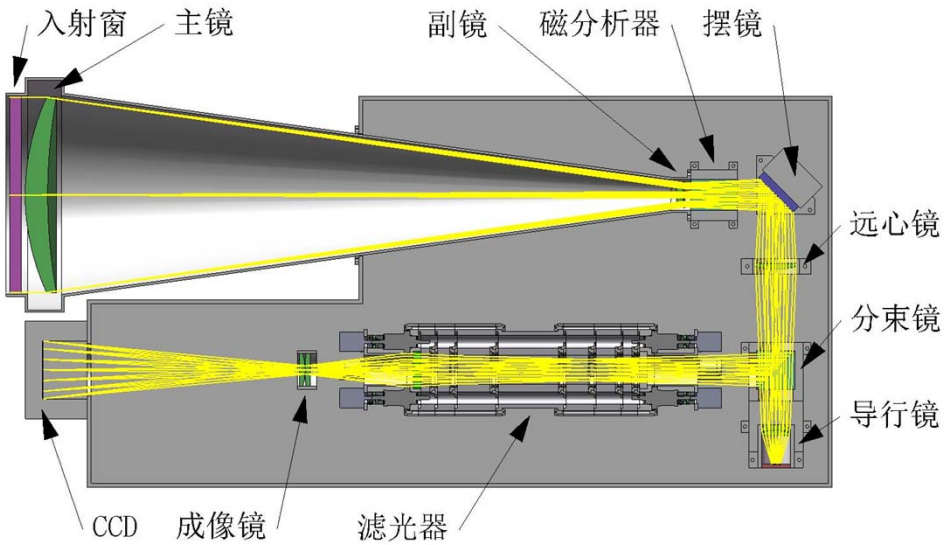
- Simultaneously observe non-thermal images of hard X-rays, and formation of CMEs, to understand the relationships between flares and CMEs
- Simultaneously observe the full disc vector magnetic field, the energy release of solar flares, and the initiation of CMEs, to understand the causality among them
- Observe the responses of solar atmosphere to solar eruptions, to understand the mechanisms of energy release and transportation, as well as the patterns of dynamics
- Observe solar eruptions and evolution of solar magnetic field, to provide clues for forecasting space weather



Payloads

- **Full-Disc Vector Magnetograph (FMG)**

PI: Yuanyong Deng (NAOC)



FOV：33′

Diameter：14 cm

Resolution：1”

CCD: 4K*4K

Wavelength：FeI532.4nm

FWHM of Filter：0.1Å

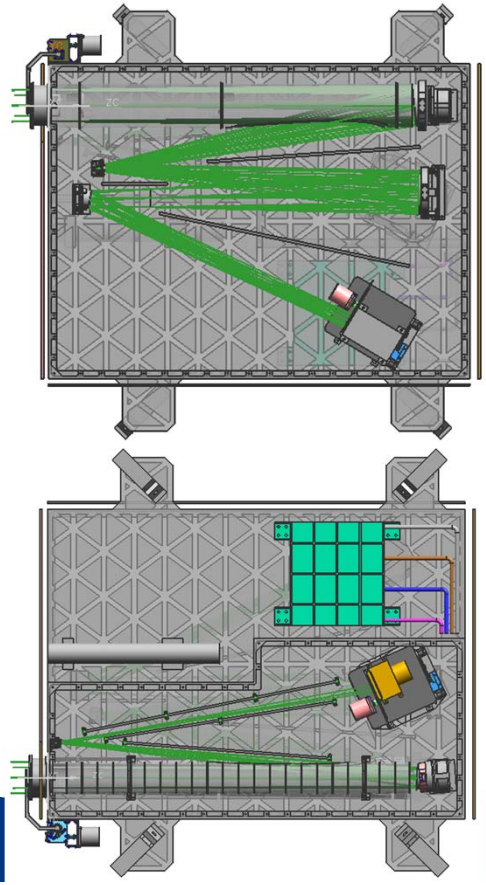
Time Resolution：2min

Accuracy of $B_{\parallel}$：5 Gs

Payloads

- **Lyman-alpha Telescope(LST)**

PI: Hui Li (PMO)

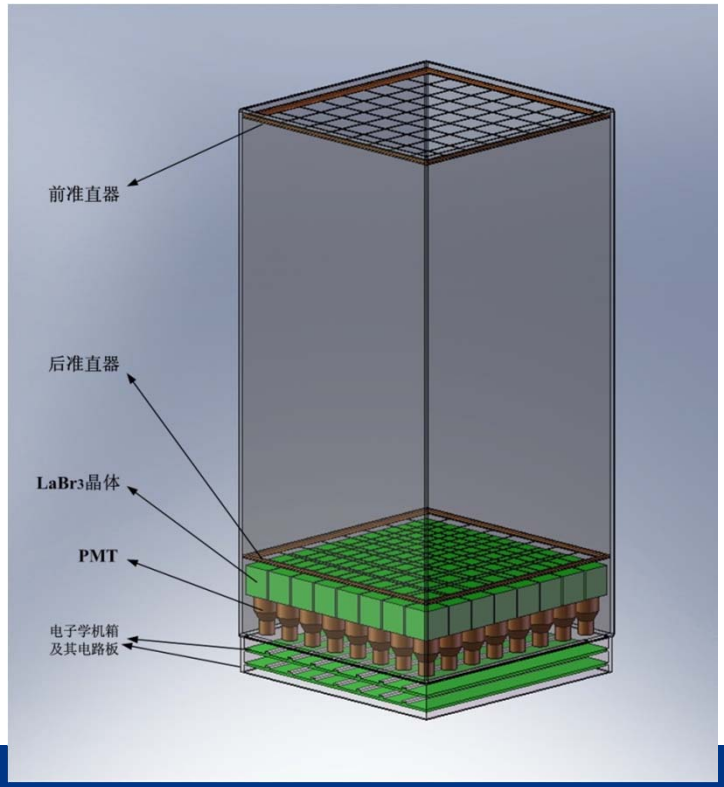


	SCI	SDI
Diameter	60 mm	40 mm
Wavelength	121.6±10.0 nm	121.6±10.0 nm
FOV	1.1 – 2.5 $R_\odot$	0.0 – 1.2 $R_\odot$
CCD	2K*2K	4K*4K
Resolution	2.35”/pixel	0.56”/pixel
Exposure	1-2 s	0.2-1 s
Time interval	4-10 s	1-5 s
Attitude Acc.	1.0-2.0"/10s (rms)	1.0-2.0"/10s (rms)

Payloads

- **Hard X-rag Imager (HXI)**

PI: Jian Wu (PMO)



Energy range: 30-300 keV

Energy Res.: 3%@662keV

Crystal: $LaBr_3$

Resolution：better than 6”

Effective area: 100 cm^2

Time Resolution：0.5 s

FOV：1^o

Mission Requirements

- **Orbit:** solar synchronous
- **Attitude**: 700-750 km
- **Attitude Control:** 3-axis stability
- **Pointing accuracy:** 0.005°/s
- **Stability**: 1-2”/10s
- **Payload Mass**: 250 kg
- **Data**: 140 GB/day
- **Launch date**: 2022
- **Lifetime**: 4 years

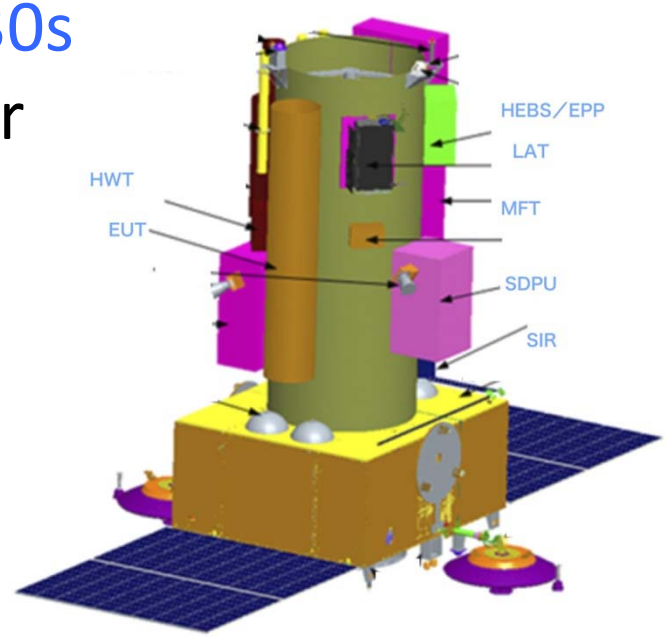
Status of ASO-S

- Feasibility-study has been supported by CAS (2013-2015)
- The Forum on the ASO-S has organized by ISSI-BJ October 2014 with nearly 30 participates from around the world of the solar community
- ASO-S has participated the selection Feb. 2015. The results will come out soon. If not selected, next chance will be in 2016.

Deep Space Observatory (DSO)

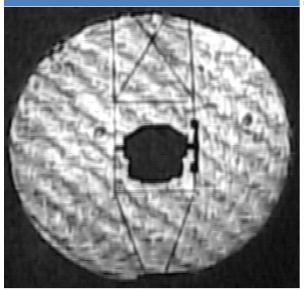
Scientific objectives:

1. To understand the nature of the solar magnetic field: @0.1-0.15 arc sec, pol. degree of 2×10^{-4} and 30s
2. To explore the mechanism of solar activity: with continuous observations in γ-ray, X-rays, EUV, visible and radio bands
3. To provide physical basis for solar activity prediction

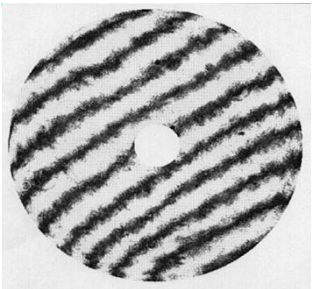


Testing process of MFT in the laboratory

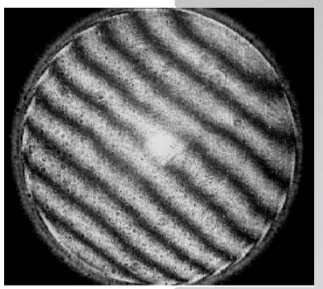
装卡后1#主镜干涉图：面形优于λ/35 RMS



1#主镜干涉图：面形优于λ/45 RMS



2#主镜干涉图：面形优于λ/40 RMS



Test result (@λ=633nm)

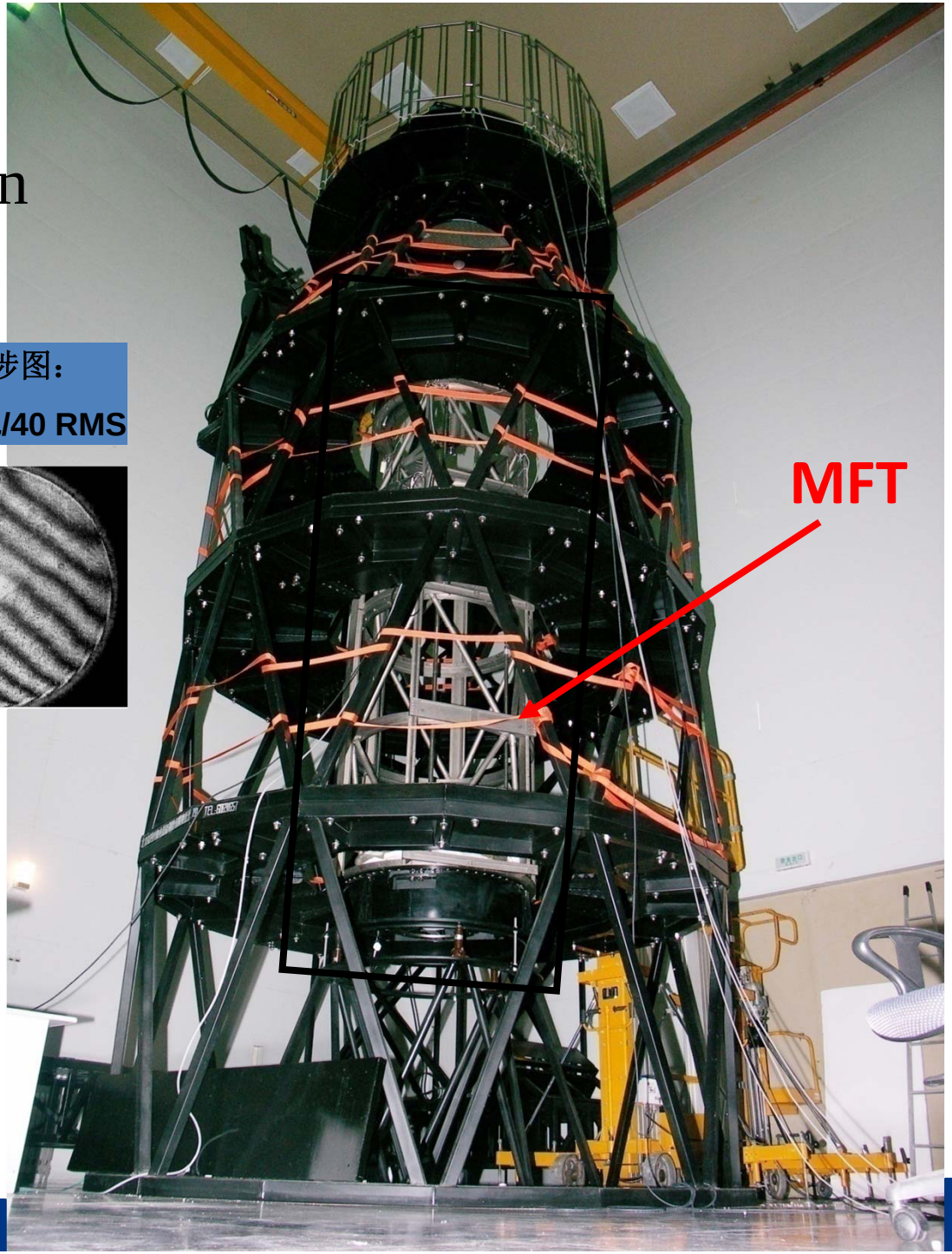
Main lens: λ/35 RMS

Autocollimetor: λ/30 RMS

Image lens: λ/35 RMS

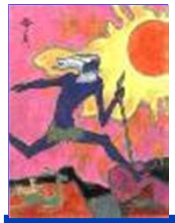
whole system: λ/17 RMS

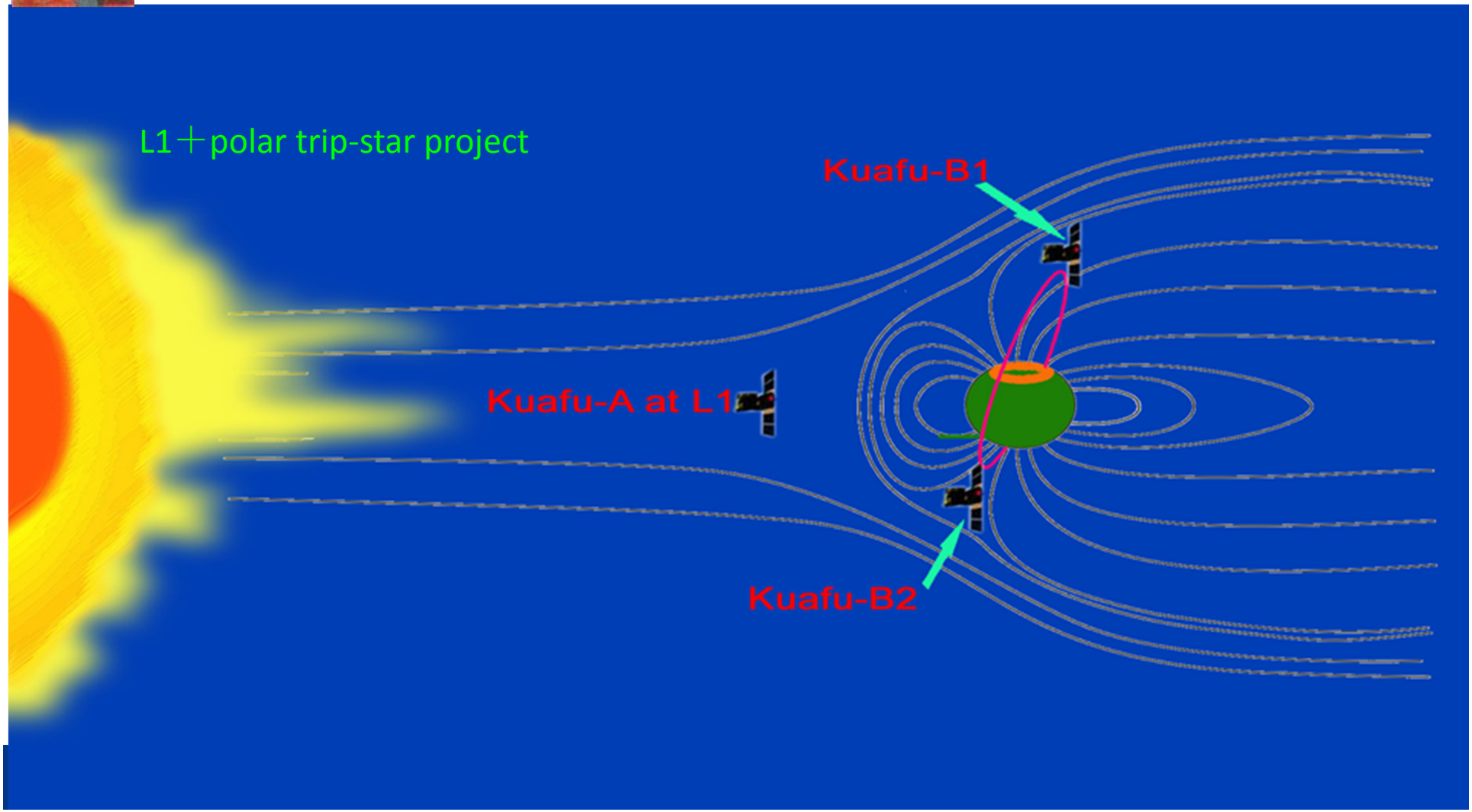
(by Sen Wang et al.)



KuaFu

Solar Storm, Aurora and Space Weather Exploration





Status of DSO and KuaFu

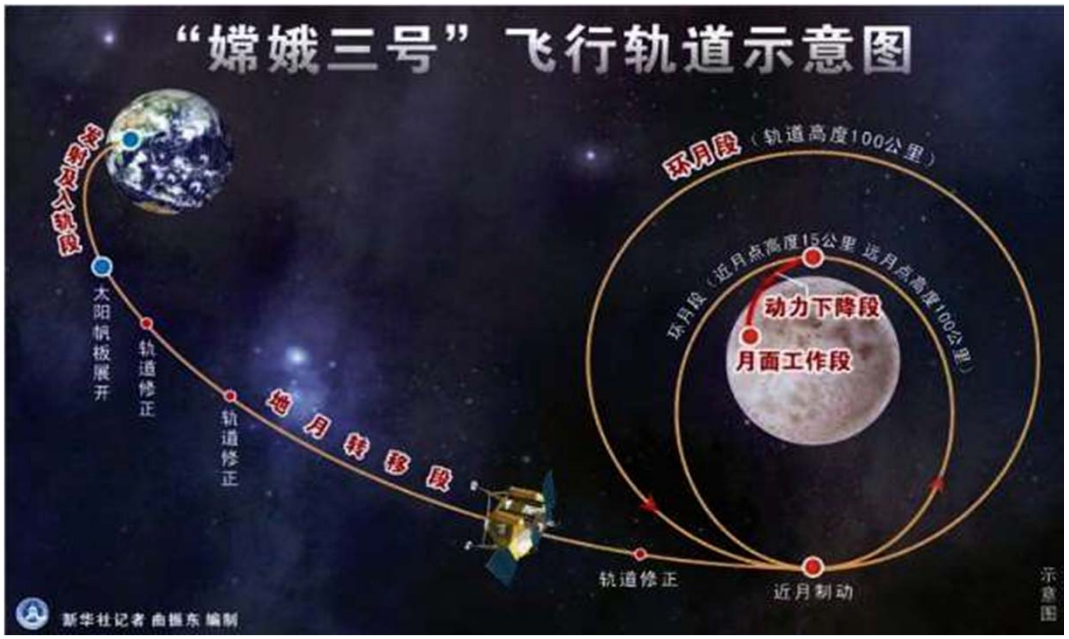
- DSO used to be a mission called SST and has been supported for payload study for more than 20 years.
- Re-proposed to CNSA as a major mission in the overall program for deep space exploration in 2011, but the deep space program is pending now
- KuaFu since the beginning is a international mission supported by ILWS with Canadian participation of KuaFu B1 and B2. Due to the lack of international participation, KuaFu is also in the status of pending until a solid international participation confirmed, it will not be reconsidered in the near term program.

China's Lunar Exploration Program

CE-1 was launched Oct. 25, 2007 – Orbiter 200km Circular, terminated with a hard encounter Mar. 1st 2009

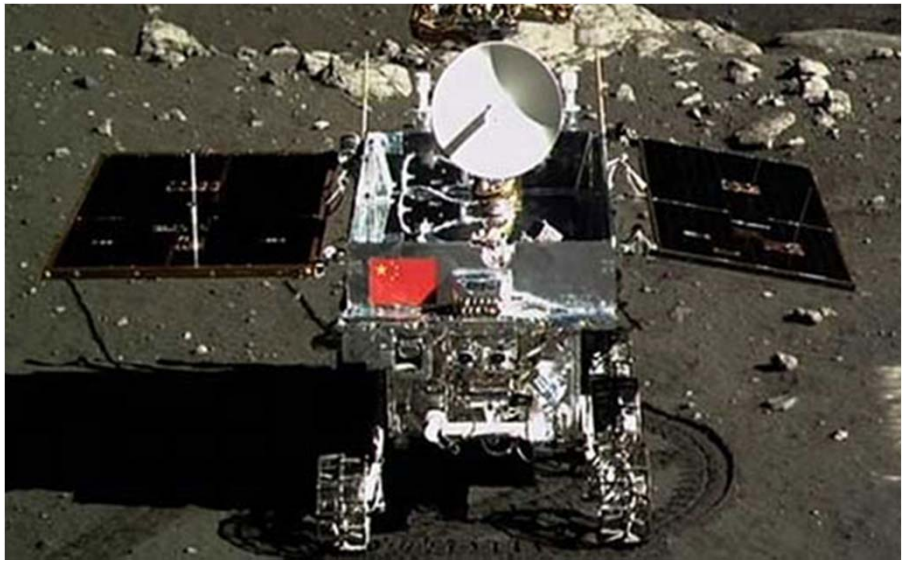
CE-2 was launched Oct. 1, 2010 – Orbiter 100km Circular, departuree from lunar orbiter to L2 on Aug. 30 2011, and then to asteroid Tutatis

CE-3 was landed on the lunar surface Dec. 15 2013 with a rover



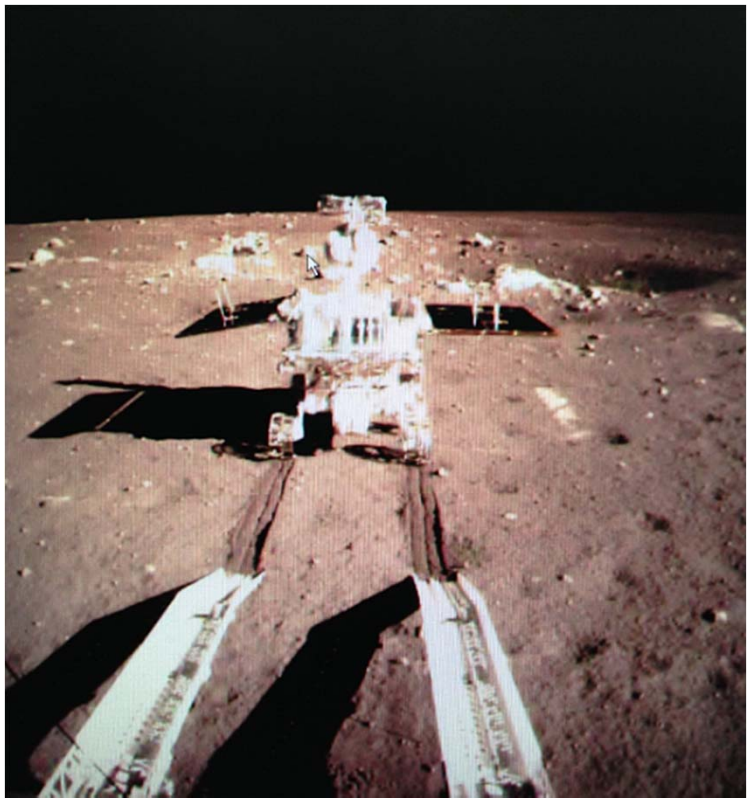
China's Lunar Exploration Program

CE-3 lander has 4 instruments:



China's Lunar Exploration Program

CE-3 lander has 4 instruments: surface topography camera, descending camera, UV astronomical telescope and EUV plasma imager; on the rover, there are also four instruments:



Stereo camera, visible and inferred spectrometer, ground penetration radar a γ-ray spectrometer

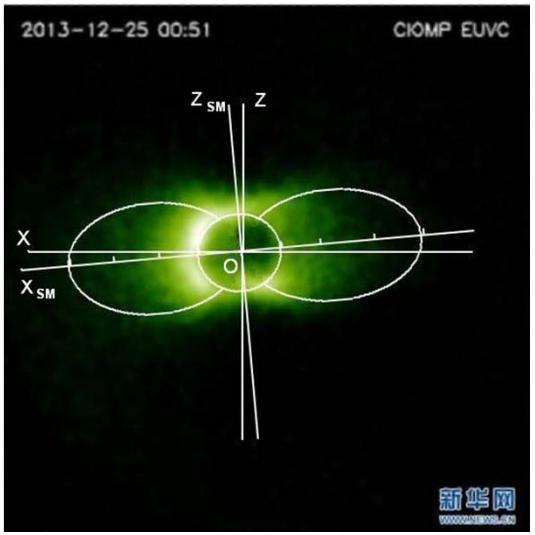


Image from the EUV plasma imager

CE-5 and Mars

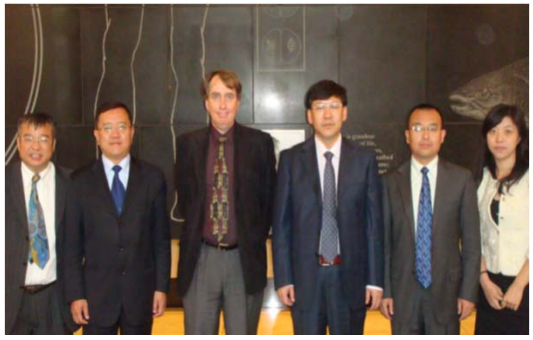
- CE-5/T test flight was launched last October and was very successful, which demonstrated the ability off high speed retrieval and also the orbiter manuve for lunar orbit docking.
- CE-5 sample return mission is under development of engineering model still and the launch date will be in 2017-2018.
- Mars mission is still under design and discussion. If there is no green light from the government, we may miss the window of 2020. The nominal mission is to have a orbiter and lander/rover in one goal.

International cooperation

- China is open on space cooperation particularly in the area of space science.
- European countries are our main partners, leaded by ESA.
- Currently a mission (S-class) will be jointly selected with ESA more than 10 proposals have been received. The selection procedure is under taken now.

International cooperation (2)

- Cooperation with US is still remaining preliminary between scientists, supported by NAS. Selected young scientists are organized to meeting each other twice a year in 2014. Next year another young scientist workshop will be organized again in the topic of earth science and planetary science.
- Canada, Russia, Australia, Thailand, Brazil, are all have cooperation relations with China in space science.



International cooperation (3)

- China is a key contributor of COSAR and hosted 2006 Assembly in Beijing, now is proposing to host COSPAR 2020
- CAS and COSAR has a joint award called JAW science award since 2008, until now 4 awards are given, 3 awardees are US scientist
- CAS/NSSC and ISSI in Bern has opened a new international space science institute in Beijing 2013. It is running very well

Remarks

- China has long history on space observations in the ancient time
- China, as a large space country, there is no fix space science budget yet. However, it already realized that space science is a very important field in basic research therefore we have a few missions under development already
- China is open for cooperation in space science programs, therefore all kind of participation with our program are welcome.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