

Future Chinese Magnetospheric & Heliospheric Missions

J. Wu and C. Wang

*Center for Space Science and Applied Research
Chinese Academy of Sciences*

2005-09-23

Outline

- Introduction
- New KuaFu
 - Solar Storm, Aurora and Space Weather Exploration
- SMESE
 - Small Mission on Exploration of Solar Eruption
- Meridian Project
 - Meridian Space Weather Monitoring Project

Introduction

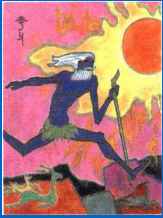
- “The White Book of Chinese Space Activities” (Nov. 2000)
- Three key development areas:
 - Space science
 - Space technology
 - Space application

Five Year Plan

- **10th Five Year Plan (2001-2005)**
 - DSP (first Chinese Scientific Space Mission)
- **11th Five Year Plan (2006-2010)**
 - Space Science Mission Evaluation Center, CNSA**
 - Call for proposals (>20 proposals submitted)
 - Individual Evaluation
 - Collective Evaluation
 - Panel Meetings
 - Recommendation by Evaluation Committee
 - Decision by CNSA

Proposals have been selected by CNSA to proceed with Phase B (preliminary design studies) for next 5 years

- **Astronomy**
- **Space Physics/Environment**
 - **New KuaFu** to study the solar storms and the geospace response
 - **SMESE** to look at the flares and CMEs
- **Microgravity-Related Science**

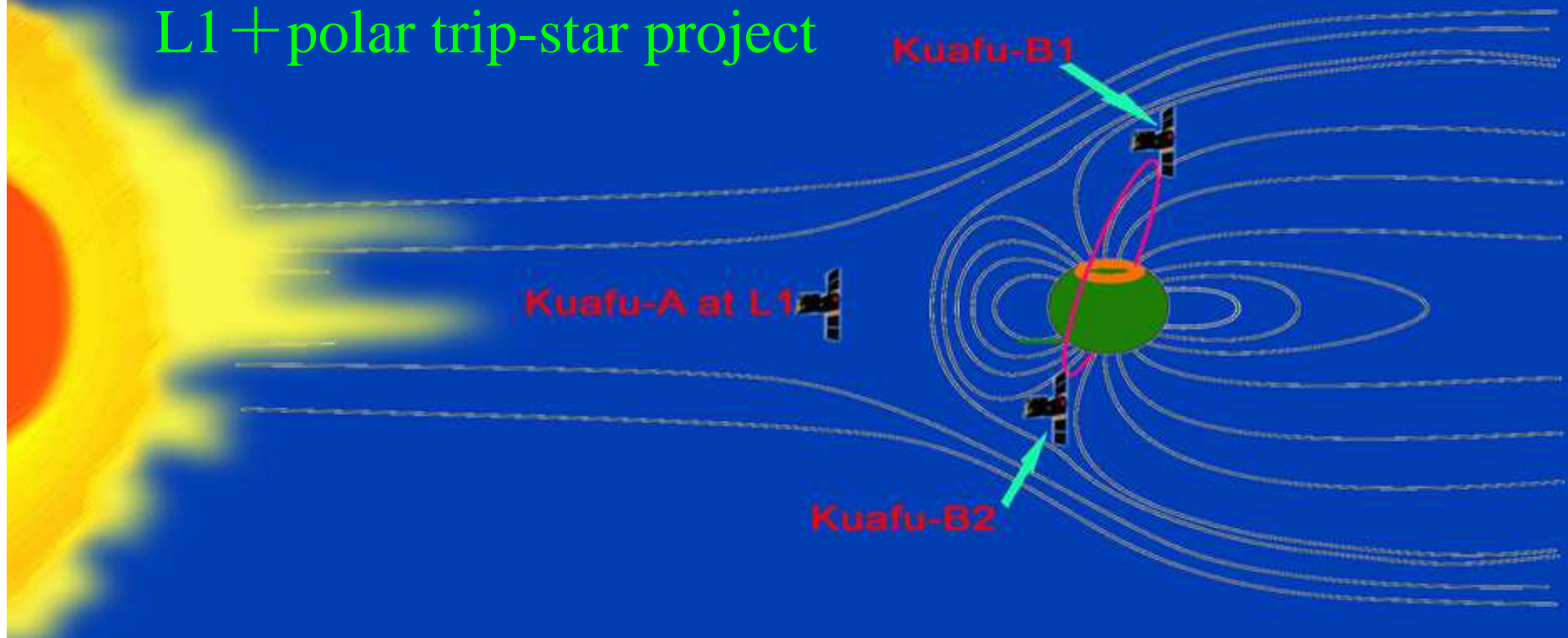


New KuaFu

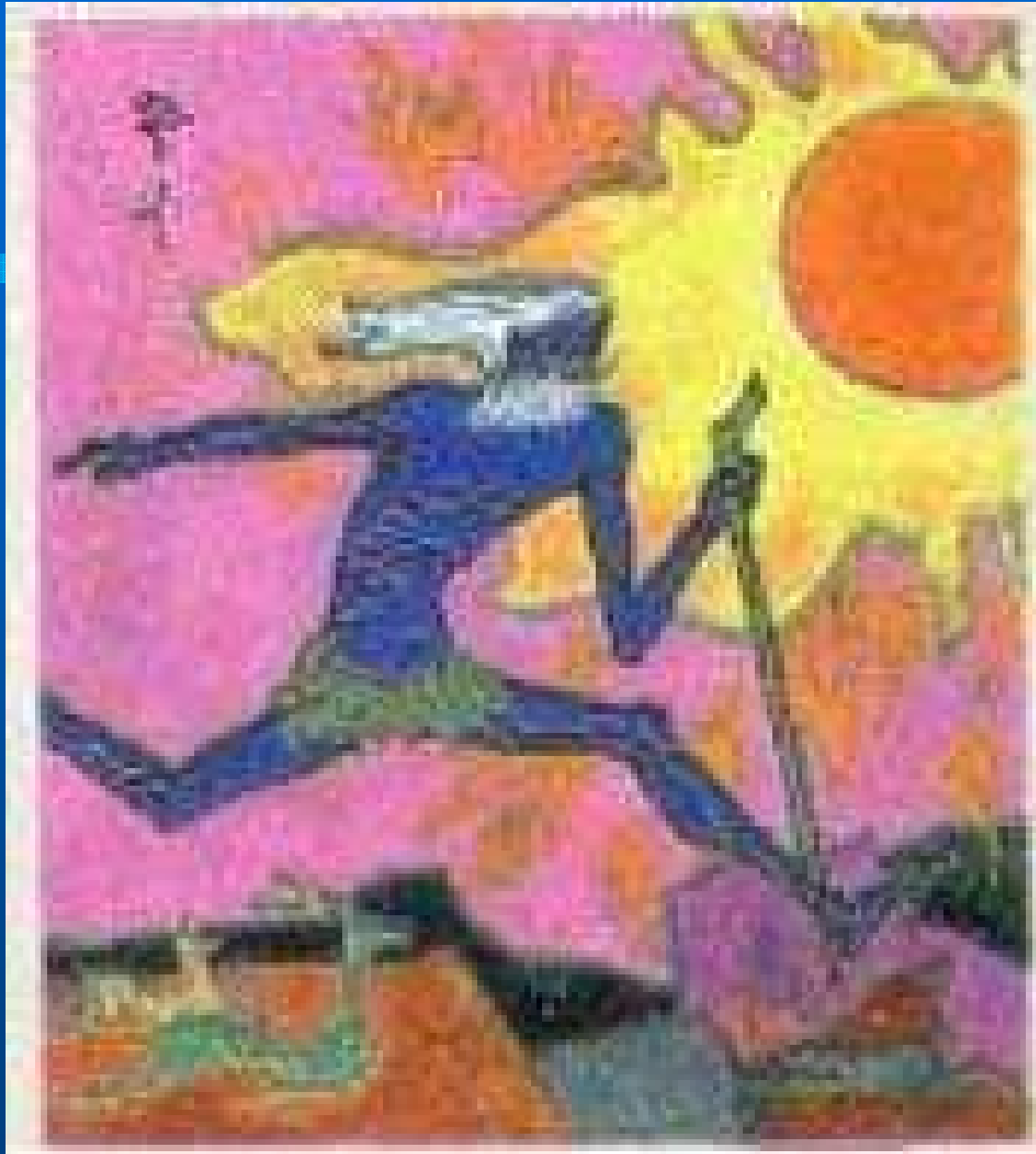
Solar Storm, Aurora and Space Weather Exploration

Launch Date: 2012

L1 + polar trip-star project



Pre-study supported by the National NSF of China



Mr. KuaFu

An ancient folk of
China:

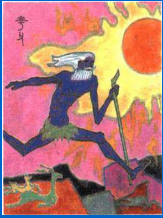
A man named
KuaFu died on his
way to pursue after
the Sun

Published on
Sept 25th, 1987, Beijing

Proposed by

Project Leader: Prof. C.-Y. Tu

- **Peking University, China**
- **Center for Space Science and Applied Research**
- **University of Science and Technology of China**
- **China Academy of Space Technology**



Team members for KuaFu assessment study and pre-study

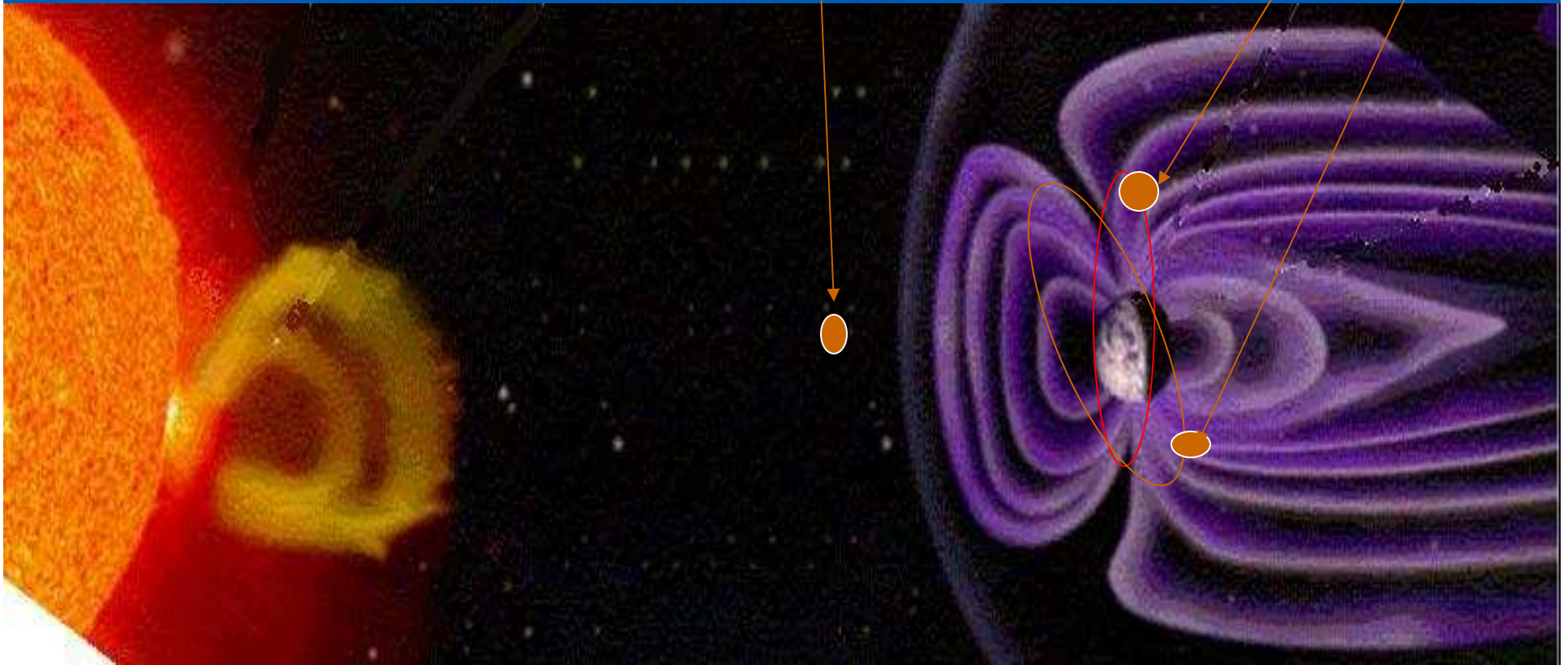
C.-Y. Tu (project leader)	Peking University
F-S. Wei	Chinese Academy of Science, Beijing, China
Z. Xiao	Peking University
Y.-W. Zhang	CAST (China Academy of Space Technology), DFH Satellite Co. LTD, China
S.-G., Yuan	CAST (China Academy of Space Technology), DFH Satellite Co. LTD, China
L.-D. Xia	University of Science and Technology of Hefei, China
Wang J.-S.	Peking University
R. Schwenn	MPS Germany
E. Marsch	MPS Germany
Udo Schühle	MPS Germany
Pierre Rochus	CSL, Parc Scientifique, Belgium
Philippe Lamy	Laboratoire d'Astronomie Spatiale CNRS, France
Jean-Louis Bougeret	Observatoire de Paris, Meudon, France
Eric Donovan	University of Calgary, Canada
Karl-Heinz Glassmeier	TU Braunschweig, Germany
Robert Wimmer-Schweingruber	Universität Kiel, Germany
Tielong Zhang	Space Research Institute, Austrian Academy of Sciences, Graz, Austria

Brief Description

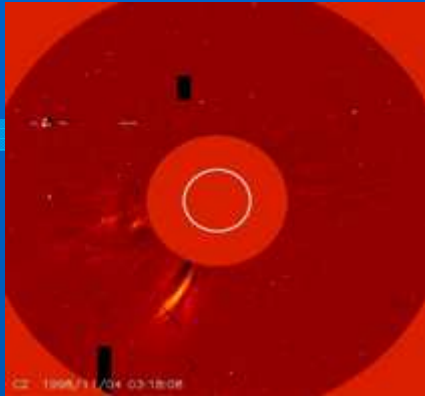
KuaFu Mission
2012-2015

KuaFu-A
at L1

KuaFu-B1+B2
Polar(2-8Re)

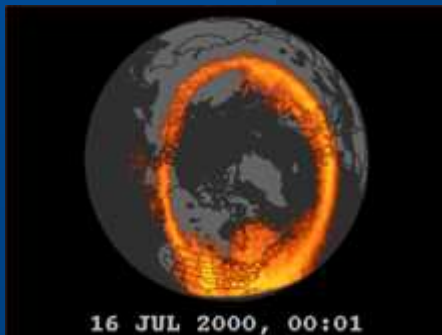


KuaFu-A at L1



Solar EUV emission
White light CME
Radio wave measurement
local plasma and magnetic field
High energy particles

KuaFu-B1+B2 polar orbit



24 hours Aurora Image,
Magnetic field
High energy particles

Scientific Objectives

To observe the complete chain of disturbance from the solar atmosphere to the geo-space:

- Solar flares, CMEs,
- Interplanetary clouds, shock waves,
- Their geo-effectiveness, such as sub-storms and magnetic storms, aurora activities

KuaFu-A Payload

Instrument	Mass (kg)	Power (w)	Data Rate (bps)
EUV/FUV Disk Imager	25	20	100k
Coronal Dynamics Imager	35	35	50k
Radio Burst Instrument	12	10	4k
Solar Wind Instrument Package	6	6	4k
Solar Energetic Particle Sensor	8	10	1k
X-ray/γ-ray Detector	3	5	1k
Total	89	86	160

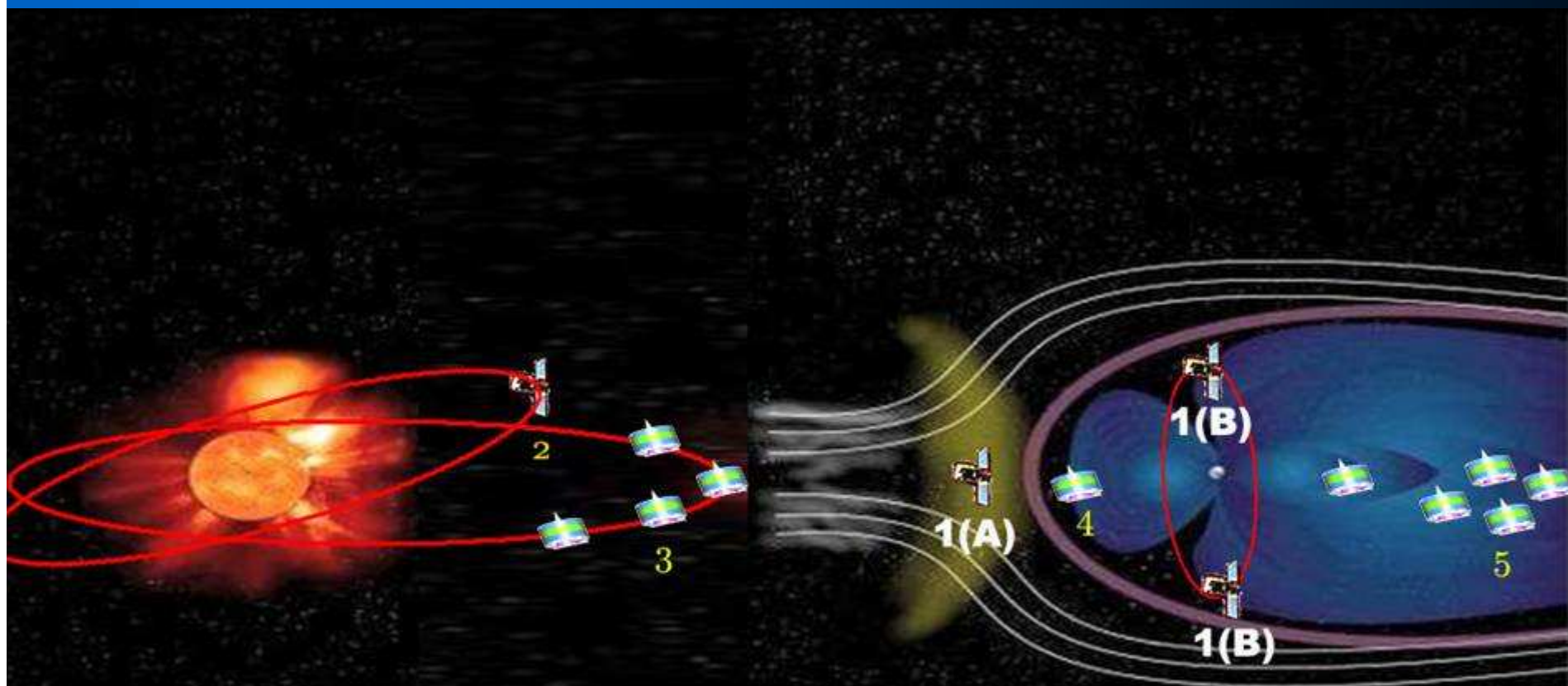
KuaFu-B Payload

Instrument	Mass (kg)	Power (w)	Data Rate (bps)
EUV Aurora Monitoring Camera	21	11	<0.5 M
FUV Aurora Spectrograph	20	4.4	
Wide-Field Aurora Imager	1.5	10	TBC
Fluxgate Magnetometer	3	4.2	3k
High Energy Particle Experiment	3	4	1k
Neutral Atom Imager	4	4	1k
Total	~60	~50	~0.5 M

KuaFu International Collaboration

- The satellite system, ground system and operation will be developed in China.
- The satellites will be launched by Chinese rockets.
- The scientific payloads are mainly prepared by partners
- The communication for scientific data transport and for tracking and control may need also international collaboration.
- The data will be open to the international space weather community.

Conjunct Observation



1(A): 夸父-A (1颗)

2: Solar Orbiter (1颗)

3: Solar Wind Sentinel (4颗)

1(B): 夸父-B (2颗)

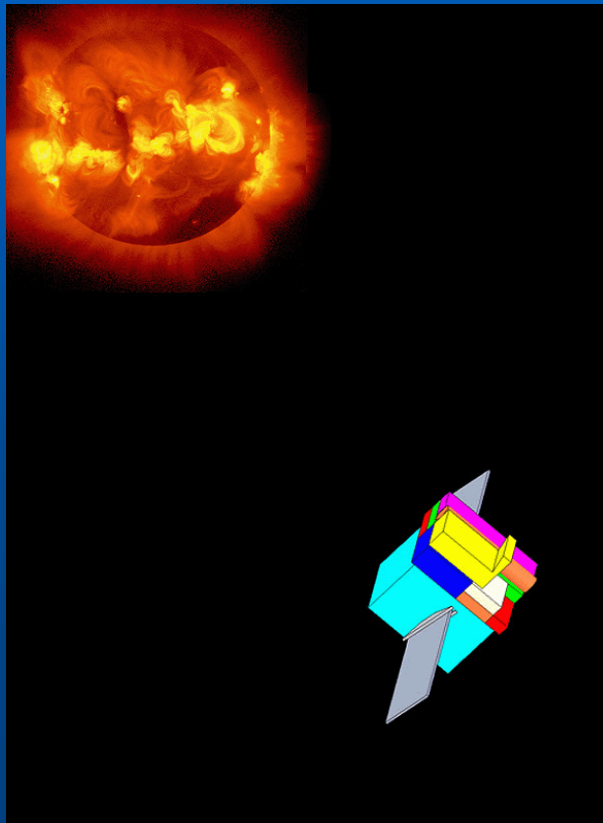
4: RBST (2颗)

5: MMS (4颗)

SMESE

Small Mission on Exploration of Solar Eruption

France-China Joint Mission



- Purple Mountain Observatory, CAS, China
- Nanjing University, China
- Center for Space Science and Applied Research, CAS, China
- National Astronomical Observatory, CAS, China
- Institut d'Astrophysique Spatiale, CNRS, France
- Observatoire de Paris, France
- Max-Planck-Institute For solar System Research, Germany

Brief description

SMESE: to observe the solar flares and CMEs
for the next Solar Maximum

Main Scientific Objectives:

- To establish the interconnections between flares and CMEs;
- To follow the disc source region of CME;
- To diagnose the high energy particles accelerated by flares and CMEs;
- To study the energy transportation mechanisms.
 - all of these
are the key ingredients of space weather!

Instrumentation:

- Lyman-alpha disc imager (up to $1.15R_{\alpha}$)
- EUV (FeXII 19.5 nm) disc imager
- Infrared telescope (35 & 150 μm)
- Lyman-alpha coronagraph (1.1 - $2.5R_{\alpha}$)
- X-ray spectrometer (10-300 keV)
- Gamma-ray spectrometer (0.2-600 MeV)

Predominance:

- the first space inner corona obs. in Ly- α
- the first space solar infrared observation
- the first flare-CME interconnected observation

Historic role:

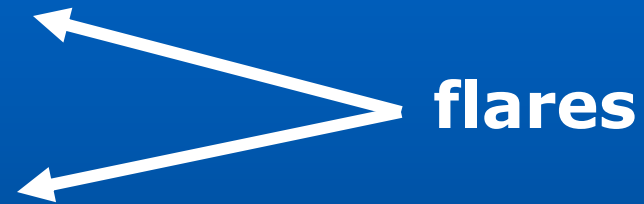
Missions for solar peak years:

Cycle 21st: SMM

Cycle 22nd: YOHKOH

Cycle 23rd: RHESSI

Cycle 24th: SMESE



It may be the unique mission specially for the 24th solar peak years!

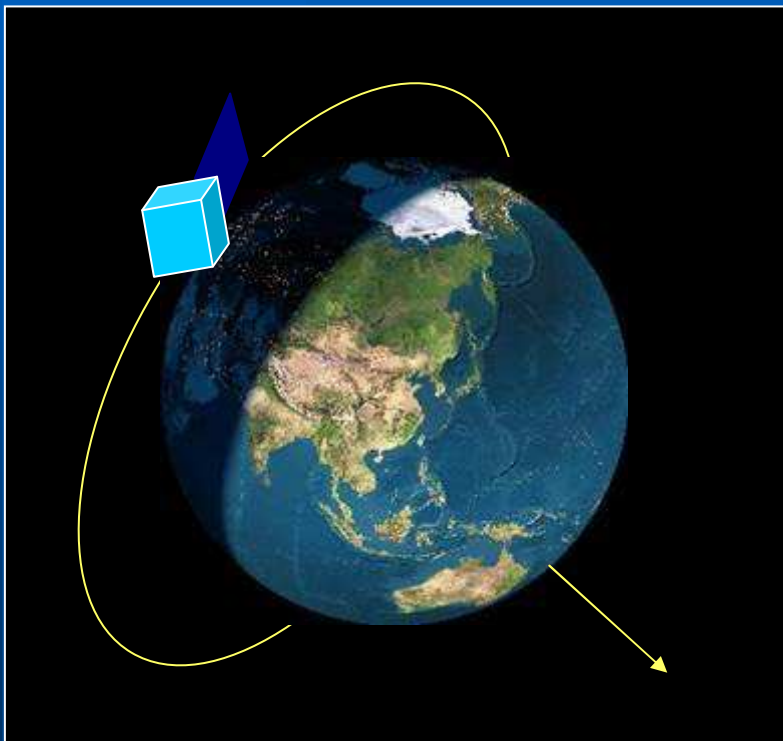
Specially suitable for studying

small size burst *versus* large scale burst
(flare) (CME)

local change *versus* global consequence
(triggering) (CME)

The relationship between flares and CMEs is a puzzle for quite a long time! To understand it is also a key to forecast Space Weather!

Mission Facts

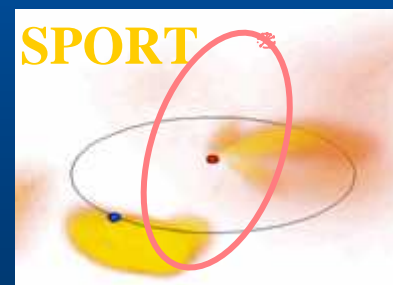
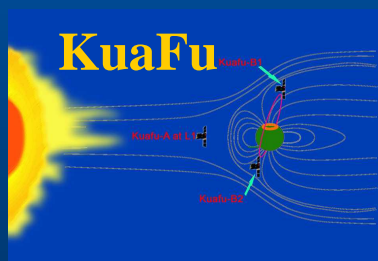
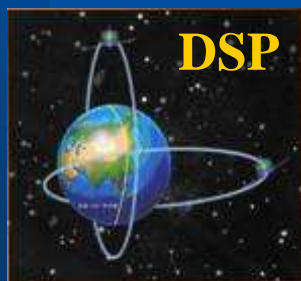
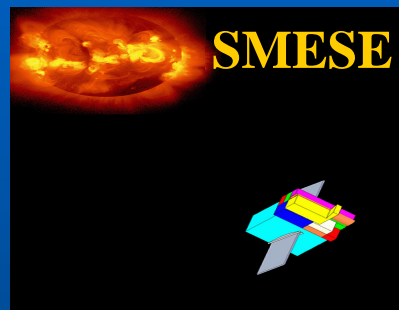


- Mass of payloads: 76 kg
- Power: 90 W
- Size of payloads: 600 × 600 × 600mm
- Attitude: Solar-pointed, three-axis stability
- Stability: 0.5 arcsec over 10s
- Telemetry: 31 Gbits/day
- Data recorder: 31 Gbits (solid state)
- Orbit: Polar, Sun Synchronous, 750 km
- Launch: 2010
- Lifetime: 3 years
- Communication: X-band

Schedule

- 2004-2005: phase-A study
- 2005-2006: phase-B
- 2006-2008: phase-C, D
- 2009-2010: launch
- Up to 2 years delay is still acceptable.

Space Physics/Environment Exploration Roadmap (2006-2025)



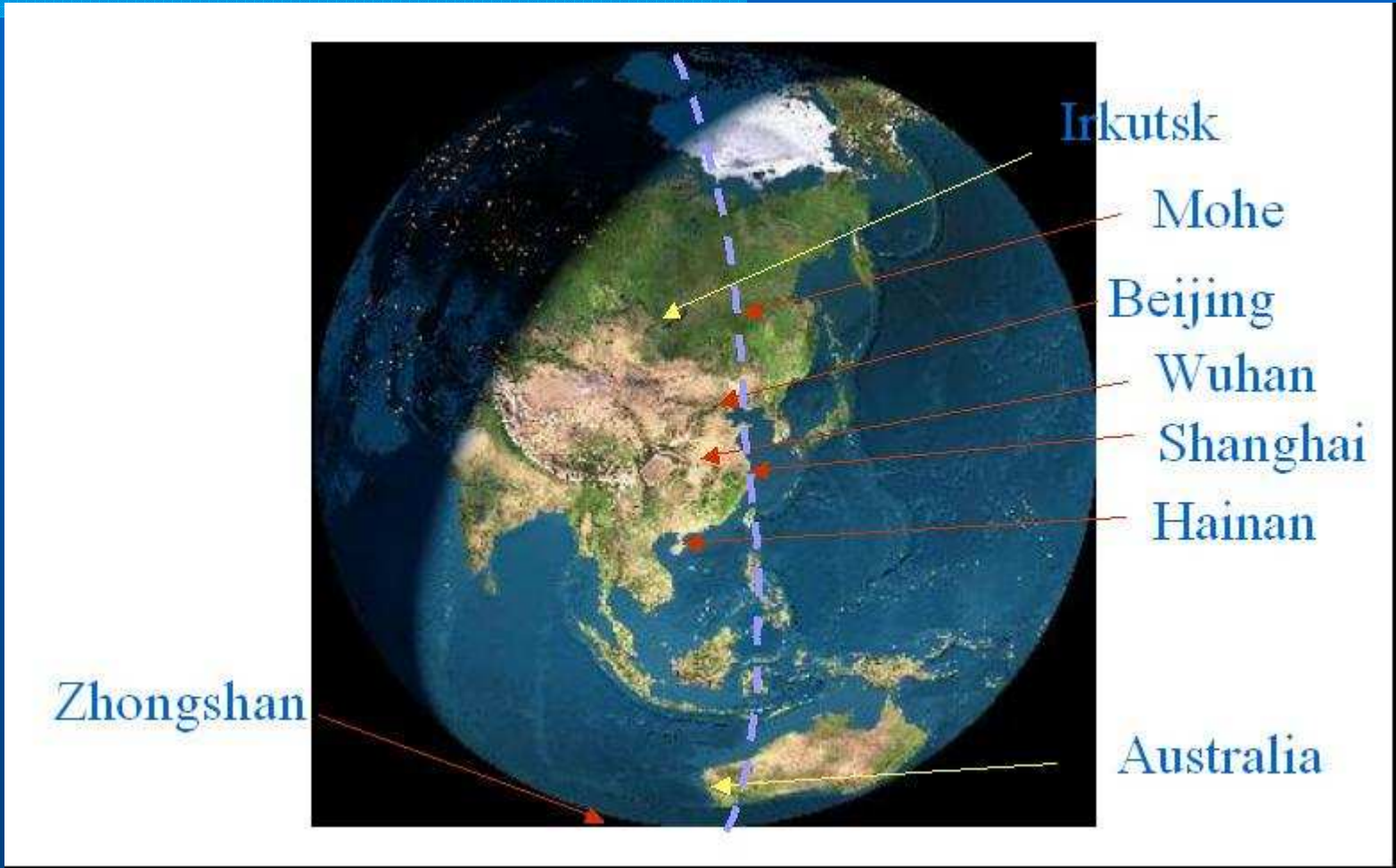


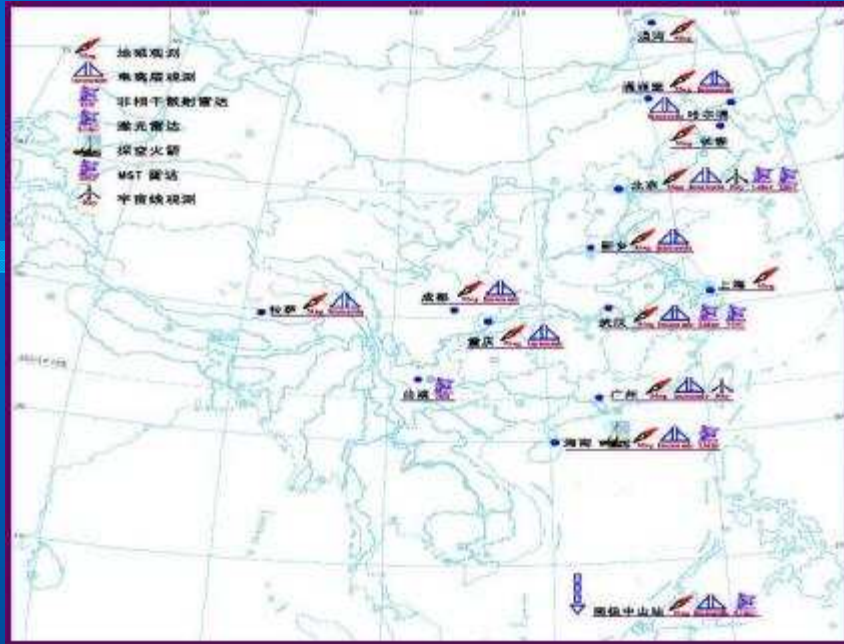
Meridian Space Weather Monitoring Project (Meridian Project)

Has been approved and funded !

This project will be completed in ~4 years.

It is a Chinese multi-station chain along 120°E to monitor space environment, starting from Mohe, the most northern station in China, through Beijing, Wuhan, Guangzhou and extended to Chinese Zhongshan station in the Antarctic.

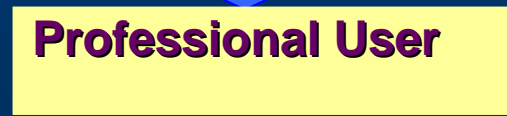
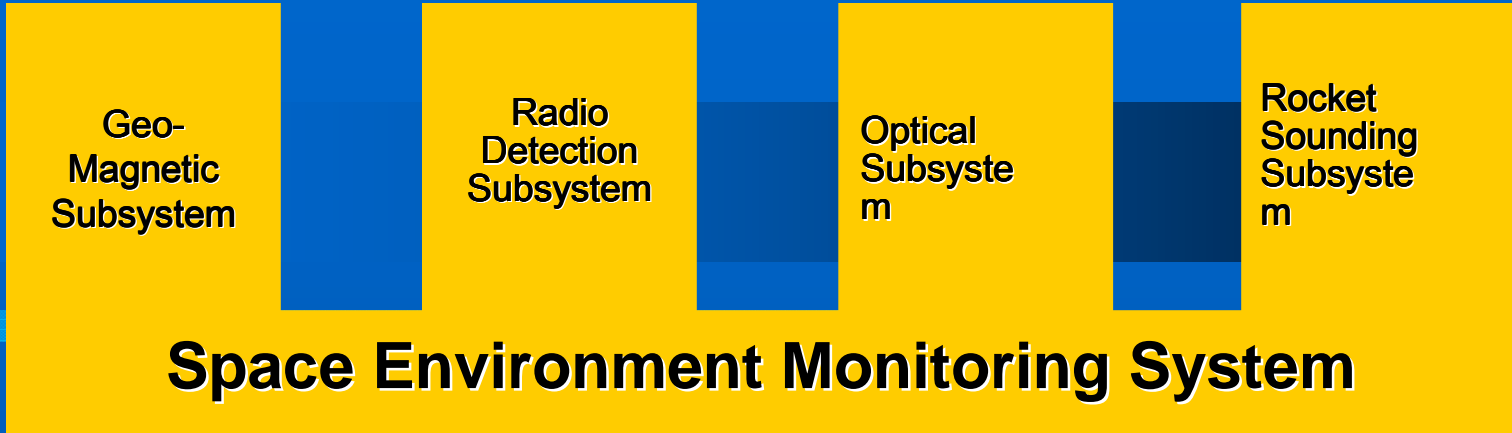




Stations Distribution

Zhongshan Station in Antarctica →





Instrument and Facilities



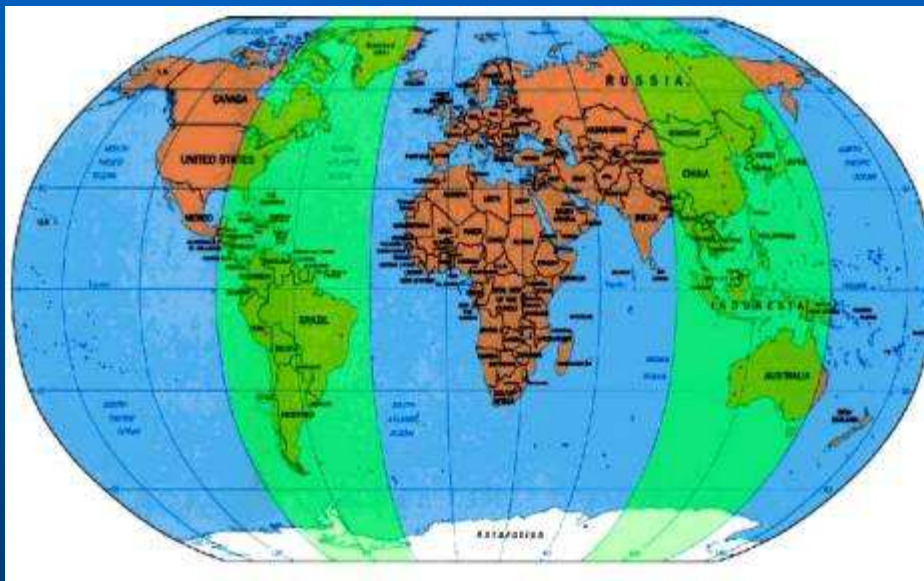
- Magnetometers
- Ionosondes and digisondes
- Incoherent Scattering Radar
- HF back-scattering radar
- VLF receiver
- LIDARS
- Fabry-Perot interferometer
- Sounding Rocket
- ...



Spatial Coverage
By
The Meridian Project

No.	Station	Lat.	Lon.	Types of Observations
01	Mohe	53.5N	122.4E	Geomagnetic
02	Manzhouli	49.6N	117.4E	Geomagnetic, Ionospheric
03	Harbin	45.5N	126.5E	, Ionospheric
04	Changchun	44.0N	125.2E	Geomagnetic
05	Beijing	40.3N	116.2E	Geomagnetic, Ionospheric, Lidar, MST radar, Optical atmospheric, IPS, Cosmic rays
06	Xinxiang	34.6N	113.6E	Geomagnetic, Ionospheric
07	Wuhan	30.5N	114.6E	Geomagnetic, Ionospheric, Lidar, MST radar
08	Guangzhou	23.1N	113.3E	Geomagnetic, Ionospheric, Cosmic rays
09	Hainan	19.0N	109.8E	Geomagnetic, Ionospheric, Lidar
10	Zhongshan	69.4S	76.4E	Geomagnetic, Ionospheric
11	Shanghai	31.1N	121.2E	Geomagnetic
12	Chongqing	29.5N	106.5E	Geomagnetic, Ionospheric
13	Chengdu	31.0N	103.7E	Geomagnetic, Ionospheric
14	Qijing	25.6N	103.8E	Incoherent Scattering Radar (ISR)
15	Lhasa	29.6N	91.0E	Geomagnetic, Ionospheric

International Collaboration



The International Space Weather Meridian Circle Program (ISWMCP), proposal to connect 120°E and 60°W meridian chains of ground based monitors and enhance the ability of monitoring space environment worldwide.

Summary

- KuaFu and SMESE have been recently selected by CNSA to proceed with Phase-B study, and are likely to be launched in the next solar maximum.
- Meridian Project has officially approved by Chinese government, and will be finished by 2009.
- International cooperation are encouraged by Chinese government to make joint effort to promote space science missions.



**THANK
YOU**