

China's Chang'E-1 Lunar Orbiter Mission

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Chang'E-1

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***Science Ground Segment and Data Products
of China's Chang'E-1 Project***

by
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Chang'E Lunar Exploration Program

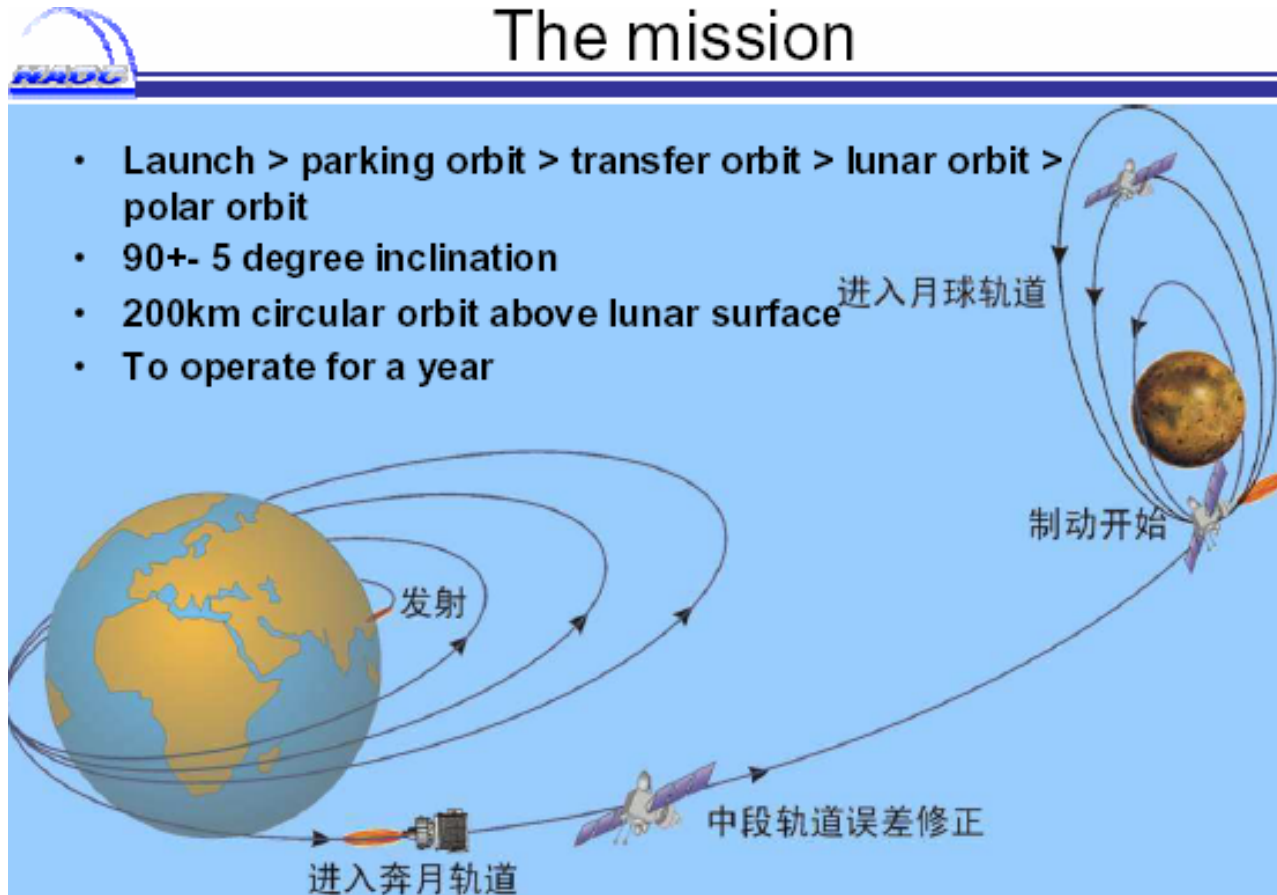
- **The Chinese National Space Administration (CNSA) plans a three-part lunar exploration program.**
 - **Stage 1: Lunar Orbiter (Chang'E-1)**
 - **Stage 2: Lander-Rover**
 - **Stage 3: Sample Return**

Chang'E-1 Lunar Orbiter

- **Launch planned for April 2007; one-year mission**
- **Science objectives:**
 1. **To study lunar surface topography;**
 2. **To analyze abundance of elements and distribution of surface materials on the moon;**
 3. **To survey the global properties of the lunar regolith;**
 4. **To probe the space environments in the vicinity of the moon.**
- **Science payload:**
 - **Stereo camera**
 - **Laser altimeter**
 - **Imaging interferometer**
 - **Gamma ray and X-ray detector**
 - **Microwave radiometer**
 - **High energy solar particle detector**
 - **Low energy solar wind detector**

Chang'E-1 Lunar Orbiter

The mission



Chang'E-1 Science Payload

- **CCD Stereo Camera**
 - 60 km swath
 - 120 meter/pixel ground resolution
 - 0.50 to 0.75 μm spectral range
- **Laser Altimeter**
 - ~200 meter footprint
 - 1064 nm laser wavelength
 - ~5 meter ranging resolution

Science Objective:

To study lunar surface topography using 3D imaging of the lunar surface.

Chang'E-1 Science Payload

- **Imaging Interferometer**
 - 25.6 km swath
 - 200 meter/pixel ground resolution
 - 0.48 to 0.96 μm spectral range
- **Gamma ray / X-ray Detectors**
 - Energy range: Th, U, K, Fe, Ti, Si, O, Al, Mg, Ca, Lu, Gd
 - Gamma ray: 300 keV to 9 MeV
 - X-ray: 0.5 to 60 keV
 - Energy resolution:
 - Gamma ray: 8% @ 662 keV
 - X-ray: 3.3% @ 5.9 keV
 - Ground resolution:
 - Gamma ray: 170x170 km (cell)
 - X-ray: ~10 km (cell)

Science Objective:

To analyze abundance of element and distribution of surface materials on the moon using spectroscopy.

- **Microwave Radiometer**

- **Ground resolution:**
 - 56 km @ 3.0 GHz
 - 30 km @ others
- **Bandwidth and center frequency:**
 - 100 MHz @ 3.0 GHz
 - 200 MHz @ 7.8 GHz
 - 500 MHz @ 10.35 GHz
 - 500 MHz @ 37 GHz

Science Objective:

To survey the global properties of the lunar regolith by measuring surface microwave radiation.

Chang'E-1 Science Payload

- **High Energy Solar Particle Detector**
 - Electron energy flux: ≥ 0.095 MeV and ≥ 2.2 MeV, 2-channel
 - Proton energy flux: 4 – 400 MeV, 6-channel
 - Alpha-particle energy flux: 13 – 130 MeV; 34-260 MeV; 117-730 MeV, 3-channel
- **Low Energy Solar Wind Ion Detector**
 - Energy range: 0.5 – 20 keV
 - 48 energy channels
 - 3.4° x 180° instantaneous field of view

Science Objective:

To probe the space environments in the vicinity of the moon.

Ground Segment for Data, Science, and Applications

- **The GSDSA is being built and will be operated by the National Astronomical Observatories, Chinese Academy of Sciences (NAOC) in Beijing.**
- **The GSDSA is the Science and Application Center for lunar and future deep space exploration.**
- **The GSDSA plans, executes, and coordinates science ground operations.**

GSDSA Responsibilities for Chang'E-1

- **Manages routine operations of the payload instruments**
- **Defines and executes science plans and operations plans of the payload instruments**
- **Receives downlinked data**
- **Generates pipeline-processed data products**
- **Stores, archives, and distributes science data products**
- **Reduces, analyzes, interprets, and helps develop applications for Chang'E data**
- **Conducts public outreach activities**

Data Processing Levels

Level	Processing
Raw data	Telemetry downlink decoded to generate source packets.
Level 0A	Source packets for each instrument extracted and separated.
Level 0B	Data from ground stations at Beijing and Yunnan merged, depacketized and decompressed.
Level 1	Raw-to-physical units converted. Housekeeping, auxiliary, and raw data for each instrument merged. Imaging Interferometer spectra generated.
Level 2A	System calibration to remove instrument effects.
Level 2B	Geometric corrections made.
Level 2C	Corrections for surface illumination differences made.
Level 3	Mosaics, maps, and data analyses are made for specific areas according to the requirements of the four scientific objectives and to customer specifications.

Data Product Size, Terabytes

Instrument	Level 0	Level 1	Level 2	Total
CCD Stereo Camera (CCD)	0.80	0.30	0.89	2.0
Imaging Interferometer (IIM)	7.68	2.82	8.46	19.0
Laser altimeter (LAM)	0.00	0.01	0.02	0.0
Gamma ray detector (GRS)	0.14	0.15	0.45	0.7
X-ray detector (XRS)	0.15	0.16	0.33	0.6
Microwave radiometer (MRM)	0.05	0.05	0.11	0.2
High energy particle detector (HPD)	0.00	0.01	0.01	0.0
Low energy ion detector (LID)	0.07	0.08	0.15	0.3
Other (PDS, UV, etc.)	0.15	0.17	0.35	0.7
Total				23.6

Estimates assume uninterrupted data taking during mission lifetime of one year.
 Level 3 data will be at least 3 TB.

Data Archive Format

- **The Planetary Data System (PDS) data format is adopted to archive Chang'E data.**
- **PDS format is similar to ESA's Planetary Science Archive format.**

International Cooperation

- **CNSA and ESA are starting to collaborate on lunar exploration.**
- **There have been meetings and discussions between GSDSA and European colleagues in various areas:**
 - **Ground stations and operations**
 - **Payload operation**
 - **Lunar data calibration**
 - **Data archive organization**
- **GSDSA is interested in mutually beneficial collaboration on data and scientific research.**