A Preliminary Suggestion for International Cooperation of Chang’E-4 Probe

Chinese National Space Administration

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I An Overview of Chang‘E-3 Probe

Mission Profile

Launch

Earth-Moon Transfer

First Mid-course Correction

Second Mid-course Correction

Lunar Orbiting

Powered Descending

100km Polar Circular Orbit

100km × 15km

Lunar Orbit Injection

Probe & Launch Vehicle Separation

Lunar Orbiting

100km Polar Circular Orbit
I An Overview of Chang’E-3 Probe

At 21:11 on 14th Dec. 2014, Chang’E-3 landed on the 44.12° N, 19.51° W northwest region of

[Image of the landing site with labeled features: lander, rover, Sinus Iridium, Mare Imbrium, Mare Serenitatis, Mare Tranquillitatis, Oceanus procellarum]
I An Overview of Chang’E-3 Probe

Chang’E-3 Probe has accomplished lunar landing, which is the second phase of China Lunar Exploration Program (CLEP) with three phases of "Orbiting, Landing and Return".

- Lunar Orbiting  2004～2009 (the first phase)
- Soft landing and roving  2008～2014 (the second phase)
- Sample return  2011～2020 (the third phase)
I An Overview of Chang’E-3 Probe

Scientific Objectives:

- lunar surface topography and geology survey
- lunar surface material composition and resource survey
- Earth plasmasphere survey and lunar astronomical observation
### An Overview of Chang’E-3 Probe

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<th>Payload</th>
<th>Mission</th>
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<td>Lander</td>
<td>Topography Camera</td>
<td>To obtain landing site optical images to study lunar geological and geomorphic feature</td>
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<td></td>
<td>Landing Camera</td>
<td>During landing process, to obtain the optical images of the landing site to analyze geological and geomorphic feature of the landing area, as well as its geological condition</td>
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<td>Extreme Ultraviolet Camera</td>
<td>During lunar day, to take extreme-UV images of plasmasphere of the earth</td>
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<td>Lunar-based Optical Telescope</td>
<td>During lunar day, to carry out lunar based optical astronomy observation</td>
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<td>Rover</td>
<td>Panoramic Camera</td>
<td>To obtain lunar surface images of roving region</td>
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<td>Lunar Radar</td>
<td>To measure the thickness of lunar soil and shallow-layer structure of lunar crust along roving route</td>
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<td>IR Imaging Spectrometer</td>
<td>To study the material composition at roving region</td>
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<td>Particle X-Ray Spectrometer</td>
<td>To analyze and explore the main elements of lunar surface materials of the roving region</td>
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I An Overview of Chang’E-3 Probe

Scientific Achievements

Fig. 1 Landing Region Picture Taken By Topography Camera

Fig. 2 Star Map Observed by Lunar-based Optical Telescope

Fig. 3 Pictures Taken by Extreme-UV Camera
I An Overview of Chang’E-3 Probe

Scientific Achievements

Fig. 4 Lunar Energy Spectrum Curve Measured by Particle X-Ray Spectrometer

Fig. 5-1 Spectrum Curve Firstly Shot by IR Imaging Spectrometer at landing region (Short Wave Infrared)

Fig. 6-1 First Channel Antennas Image Detected by Lunar Radar

Fig. 5-2 single band gray level image firstly shot by IR Imaging Spectrometer at the landing region

Fig. 6-2 Second Channel Antennas Image Detected by Lunar Radar
II An Introduction of Chang’E-4 Probe

- Probe (Lander, Rover) + Relay Satellite
- Soft-landing on lunar farside
- Landing and roving exploration
- Will be launched between 2018 and 2019
II An Introduction of Chang’E-4 Probe

The probe:

- Chang’E-4 probe, lander and rover have the same technical status with the Chang’E -3; but exploration will be redesigned; the payload will be reconfigured; The name of the probe might be changed.

- Chang’E-4 probe is a backup spacecraft of Chang’E -3 probe. By now, all platform products of the probe have been manufactured, waiting for further AIT.

- The probe will be launched by a long March 3B rocket from the Xichang Satellite Launch Center(XSLC) which is the same way with the Chang'E-3 between 2018 and 2019.
Ⅱ An Introduction of Chang’E-4 Probe

The relay satellite:

- will be first launched into a lunar transfer orbit about the end of 2018 in the whole mission, then starts its earth-to-moon journey alone, and will enter and run in a Halo orbit around the Earth-Moon L2 point; the design life is 3 years.
- would provide relay service for the probe and the Earth, and carry out exploration.
Engineering objectives are as follow.

- To realize the first soft landing on the lunar farside and perform exploration in human history.
- To demonstrate technologies of lunar data relay, landing and roving on complicated terrains of the lunar farside, and lunar night power generation;
- To perform further detailed survey on lunar environment in order to lay a foundation for subsequent lunar exploration mission.
Tentative Scientific objectives are as follow.

- To study lunar surface dust features and its formation mechanism;
- To perform in-situ measurement of lunar surface residual magnetism and study its interaction with solar wind;
- To study lunar surface temperature and particle radiation environment;
- To perform lunar surface topology and material composition analysis, shallow-layer structure survey and study;
- To explore and study lunar interior structure of spheres;
- To perform lunar based VLF astronomical observation and study.
We expect to promote international cooperation on Chinese future lunar exploration activities especially on present Chang'E-4 mission widely, and the Participant could be country, organization, and company.

Several possible ways of cooperation are proposed as followed.

- On mission level.
- On equipment.
- On other aspects.
III International Cooperation Intentions

On mission level:

- Participants may respectively launch their probes, and construct communication network on lunar surface, then carry out joint exploration.
- Participants may respectively launch their probes, and carry out coordination landing test on lunar surface, realize high-precision landing, perform experimental verification for lunar base.
III International Cooperation Intentions

- **On equipment level**: Participants may provide some scientific payloads or other small experimental equipment which could be carried by Chinese lander, rover or satellite.

- **On other aspects**: Foreign side provides deep space network TT&C support during its visible pass; participants share the data of lunar exploration, and carry out data analysis and scientific research.
Thank you!