

CAS in China's Lunar Exploration Program

The Chinese Academy of Sciences (CAS) is among the initiators of the China Lunar Exploration Program (CLEP), and has directly contributed to this grand program. The Academy proposed the scientific goals of the program; as a co-organizer and important contributor, it has overseen its implementation to secure the fulfillment of the preset goals, providing strong S&T support. During the whole process, institutions under its administration have undertaken a lot of important tasks from CLEP. Their participation in the historic CLEP missions has led to breakthroughs in many fields.

As an objective-setter for CLEP, the Academy proposed the layout and scientific goals for the program, and sees to its implementation with support from its 100⁺ institutes spreading across the country. Represented by the National Astronomical

Observatories, CAS (NAOC), the National Space Science Center (NSSC), CAS, and the Shanghai Astronomical Observatory, CAS, involved institutions under the Academy's umbrella have taken charge of R&D of the ground application system, the onboard payloads, the precise orbit determination with its Very Long Baseline Interferometry (VLBI) network, the engineering support system as well as related key modules, and the analysis of the scientific data.

Since 2004, CAS has successfully accomplished the engineering R&D and scientific detection involved in the missions of *Chang'e-1*, 2, 3 and 4, breaking through in many fields, including the data transfer to and from the Moon, accurate measurement and determination of the orbit of the spacecraft using VLBI network, the R&D of payloads, and processing and analysis of the data produced from the missions.



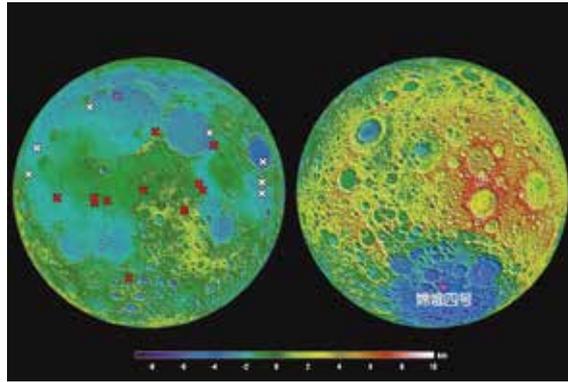
A view of the Earth over the far side of the Moon, taken by the *Chang'e-5* test vehicle on October 28, 2014. (Credit: CAST)

Since the first mission of CLEP, CAS as an important contributor has notched a lot of achievements of international importance. For example, based on the data obtained by *Chang'e-2*, scientists for the first time revealed the distribution of microwave radiation brightness temperatures on the lunar surface; based on the data from *Chang'e-3*, scientists discovered a new type of rock near the landing site, and reconstructed possible geological evolution of this area.

CLEP caught the eye of the whole world in January 9th, 2019, when *Yutu-2*, the rover of *Chang'e-4* mission successfully performed a soft-landing on the far side of the Moon – the first time ever for man-made spacecraft to do so. *Queqiao* – the relay satellite that bridged the gap in data transmission from the lunar far side to the Earth, also represents an innovative breakthrough in data transfer.

The overall development layout of China Lunar Exploration Program (CLEP) is divided into three major stages, with the first focusing on robotic exploration,

the second on manned landing, and the third on human residence. The current stage of CLEP (from 2004 till 2020) is named *Chang'e* Program after a legendary fairy dwelling on the Moon in Chinese mythology. For more about CLEP, including its middle- and long-term layout, please refer to Page 72, Vol. 33, No.2 of *BCAS*.



Before *Chang'e-4*, all lunar rovers landed on the near side of the Moon (left). On the right shown is the landing site of *Chang'e-4*. (Credit: NASA/GSFC/MIT)



On January 9, 2019, *Yutu-2*, the lunar rover of *Chang'e-4* mission, landed softly at the Von Kármán crater on the far side of the Moon. (Credit: CLEP/GRAS)