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Preface: The Chang'e-3 lander and rover mission to the Moon

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Abstract The Chang'e-3 (CE-3) lander and rover mission to the Moon was an intermediate step in China's lunar exploration program, which will be followed by a sample return mission. The lander was equipped with a number of remote-sensing instruments including a pair of cameras (Landing Camera and Terrain Camera) for recording the landing process and surveying terrain, an extreme ultraviolet camera for monitoring activities in the Earth's plasmasphere, and a first-ever Moon-based ultraviolet telescope for astronomical observations. The Yutu rover successfully carried out close-up observations with the Panoramic Camera, mineralogical investigations with the VIS-NIR Imaging Spectrometer, study of elemental abundances with the Active Particle-induced X-ray Spectrometer, and pioneering measurements of the lunar subsurface with Lunar Penetrating Radar. This special issue provides a collection of key information on the instrumental designs, calibration methods and data processing procedures used by these experiments with a perspective of facilitating further analyses of scientific data from CE-3 in preparation for future missions.

Key words: Chang'e-3 — Moon lander — rover — radar — lunar telescope

The Moon, our nearest neighbor, has always captured humans' imagination. Like the Earth, the Moon was differentiated into a crust, mantle and core. Its smaller size compared to Earth means it lost its internal heat at a faster pace, resulting in a more accelerated thermal evolution. Without plate tectonics or an atmosphere, the lunar surface has preserved the impact cratering history of the inner solar system, providing scientists with an excellent laboratory to study solar system evolution as well as a tool to date the ages of planetary surfaces. From the 1950s to the end of the last century, the United States, the Soviet Union and Japan carried out a total of 121 missions to the Moon. In the 21th century, with the launch of the European Space Agency's Smart-1 (2003), Japan's SELENE (2007), China's Chang'e-1 (2007) and Chang'e-2 (2010), and India's Chandrayaan-1 (2008), more players have joined the international exploration of the Earth's natural satellite. This new wave of exploration has returned an unprecedented amount of data from the Moon, equipping researchers with powerful resources to answer questions on the origin and evolution of our neighbor as well as our own planet.

The Chinese Lunar Exploration Program (CLEP) is strategically divided into three phases to ultimately achieve robotic sample return from the Moon (Lin & Ouyang 2014). These three phases can be summarized as "Orbiting (Phase I), Landing (Phase II) and Sample Return (Phase III)." The

Chang'e-1 Mission (2007–2009) surveyed the Moon from a polar orbit, or Phase I of CLEP, returning image maps and topographic maps of the lunar surface with the highest resolution and most complete coverage at that time. The world's first passive, multi-channel microwave observation of the Moon was also carried out by Chang'e-1. The Chang'e-2 (CE-2) mission (launched 2010) acquired high-resolution (1–1.5 m) imaging of future landing sites. CE-2 also conducted surveys that generated image maps and topographic maps of the whole lunar surface with the highest resolution currently available (7 m). CE-2 spacecraft was subsequently maneuvered into an interplanetary trajectory for rendezvous with the near-Earth asteroid 4179 Toutatis on 2012 December 13 obtaining high-resolution observations of its surface for the first time (Huang et al. 2013; Zhu et al. 2014; Zou et al. 2104).

The Chang'e-3 (CE-3) mission was selected as the first mission of Phase II of CLEP to explore the Moon from its surface (Lin & Ouyang 2014). Its goals were to analyze the morphological, structural and compositional characteristics of the landing area in northern Mare Imbrium through in-situ investigation (Li et al. 2014; Liu et al. 2014; Wang et al. 2014; Tan et al. 2014), to monitor the structure and dynamics of Earth's plasmasphere (Chen et al. 2014; Feng et al. 2014) and conduct Moon-based astronomical observations (Wen et al. 2014). It landed at 19.51°W and 44.12°N on 2013 December 14, and the Yutu rover was deployed from the lander several hours later on December 15 to start its traverse along a planned path as instruments on both platforms started to collect data. To achieve the mission's science goals, the Landing Camera (LCAM) and Terrain Camera (TCAM) on the lander and the Panoramic Camera (PCAM) on the rover investigated the morphological features and geological structures near the landing area (Ren et al. 2014). The VIS-NIR Imaging Spectrometer (VNIS: see He et al. 2014; Liu et al. 2014) and Active Particle-induced X-ray Spectrometer (APXS: see Fu et al. 2014) on the rover detected the mineralogical and chemical composition along the traverse path. Lunar Penetrating Radar (LPR) obtained data on the structure of the regolith layer and upper crust at depths up to hundreds of meters below the lunar surface (Dai et al. 2014; Su et al. 2014; Zhang et al. 2014). In addition, the Extreme Ultraviolet Camera (EUVC: see Chen et al. 2014; Feng et al. 2014) and Moon-based Ultraviolet Telescope (MUVT: see Wen et al. 2014) on the lander made observations of the terrestrial plasmasphere and the diurnal sky respectively in ultraviolet wavelengths. This volume provides detailed descriptions of the CE-3 mission, instrument calibration and data processing pipeline.

The purpose of this special issue of the journal Research in Astronomy and Astrophysics (RAA) is twofold. The first purpose is to introduce some preliminary science results of the CE-3 mission. The second purpose is to provide an introduction to the science instruments, calibration procedures, data processing methods and science data products, so that researchers who conduct analysis with such data will have a systematic understanding and use proper citations, so they can achieve more and better research results with in-depth and accurate understanding of these scientific data.

The success of the CE-3 mission has depended on the hard work and dedication of many individuals and team members. In this case, the five systems of CLEP (Launch Vehicle System, Launch Site System, Ground Research and Application System, Tracking, Telemetry and Command System, and Spacecraft System), payload management, and the scientists involved in the observation campaigns have closely collaborated to ensure the successful completion of planned science and engineering goals. We thank all of them for their essential contributions. The Guest Editors benefited from the excellent and constructive advice of the reviewers without which this special issue would not be possible.

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