THE SCIENTIFIC DATA AND ITS ARCHIVING FROM CHANG'E 4 MISSION. Z. B. Zhang[1], W. Zuo[1], X. G. Zeng[1], X. Y. Gao[1] and R. Xin[1], [1]National Astronomical Observatories, CAS (20A Datun Rd., Chaoyang district, Beijing, China, 100101, zzbin@nao.cas.cn).

Introduction: China's Chang'e-4 probe touched down at lunar longitude 177.5999°E, latitude 45.4447°S in crater Von Kármán at 10:26 (Beijing Time) on January 3, 2019. The successful landing of the probe marks the first ever soft-landing on the lunar far side for humanity. Chang'e-4 mission, including a lander and a rover, will perform a variety of science investigations over the coming months on this uncharted territory. The acquired scientific data by various onboard instruments will potentially give scientists an unprecedented view into the Moon's far side to better understand the structure, formation and evolution of the Earth's natural satellite.

This paper introduced the overall scientific data products hierarchy derived from China's Chang'e 4 mission and its overall archiving procedure.

Data types: All scientific data is processed and organized by instruments and data processing levels.

Payloads onboard the lander. Four instruments were carried on the lander, see Table 1 below:

Table 1 Instruments onboard the lander

Instrument	Goal
Landing Camera (LCAM)	Obtain images of the landing site at various altitudes during the descent phase of the probe.
Terrain Camera (TCAM)	Take 360° panoramic images surrounding the landing site.
Low-Frequency Radio Spectrometer (LFRS)	Detect low frequency electric fields from the sun, interplanetary space and Galactic space.
Lunar Lander Neutrons and Dosimetry (LND)	Measure the lunar surface integrated particle radiation dose and the LET spectra, the lunar surface fast neutron spectrum and thermal neutron spectrum.

Payloads onboard the rover. Four instruments were carried on the rover, see Table 2 below:

Table 2 Instruments onboard the rover

Instrument	Goal
Panoramic Cameras (PCAM)	Obtain continuous 3D image profiles along the cruise path of the rover.
Lunar Penetrating Radar (LPR)	Detect the lunar subsurface structure, the thickness and structure of the lunar regolith along the cruise route.
Visible and Near-infrared Imaging Spectrometer (VNIS)	Acquire the visible spectral images and infrared spectral curve around the cruise path for analysis of lunar surface mineral constituent and distribution.
Advanced Small Analyzer for Neutrals (ASAN)	Study the memory mechanism of lunar surface sputtering process of the lunar atmosphere, and measure in-suit at the surface the energetic neutral atom fluxes backscattered from the lunar surface

Payload onboard the relay satellite. Netherlands-China Long Wavelength Explorer (NCLE), carried on relay satellite residing in Earth-Moon L2 halo orbit, is designed to map the radio sky at low frequency band for studying the large scale of the Galaxy, and to detect and explore the solar radio burst and planetary radio bursts[1].

Data level. Several scientific data levels were designed depending on different data processing, see Table 3 below.

Table 3 Data levels

Data level	Data description
Frame data	Downlink data stream, demodulated, bit and frame synchronized, descrambled, channel decoded, in the form of data frame sequence
Level 0A	Individual payload data packages after channel demultiplexing
Level 0B	payload measurements with data received by different antennas combined, de-duplicated, unpacked, and decompressed based on Level 0A
Level 1	Data product after numerical conversion of temperature, voltage, current and other instrument parameters, and reorganized by exploration period on the basis of the 0B data product.
Level 2A	Calibrated data products
Level 2B	Products with geometric positioning information provided.
Level 2C	Product with further processing according to different payloads

Data archiving: Unlike the geographically distributed nature of the planetary data system, all data related procedures are proceeded in the headquarter of Ground Research and Application System of Chang'e mission in a centralized manner. Three modularized subsystem were designed to coordinate the entire dataflow business procedure: Operation Management Subsystem (OMS) schedules the workflow of the other two subsystems via a predefined exploration plan, data preprocessing subsystem (DPS) is responsible for producing Level 0 ~ Level 2 data products using established algorithms based on the frame data transferred by OMS, and data management subsystem (DMS) responses to the archiving requests from OMS and DPS and acts as a centralized data repository.

A data archiving request will be sent to DMS in a scheduled task when all data is ready by OMS or DPS, together with a XML archive list file recoding all product files' properties such as file name, location, file size, etc. Once the request is received, DMS will parse the XML list file to verify all the claimed files, and check all data labels for their compliance to PDS based on a data dictionary containing predefined PDS label blueprint and rule lists. Only when all the inspected items are qualified, metadata of each data product file

will be extracted from its PDS label and fields of its normalized filename for a successful archiving.

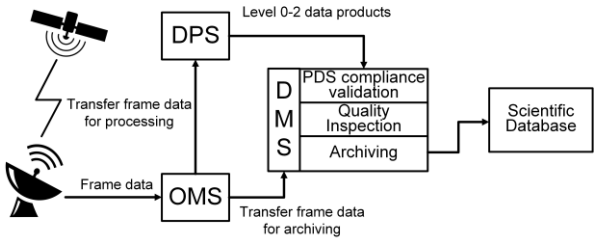

Fig. 1 Data archiving procedure

Data format: Instead of PDS 3.0 used in previous Chang'e missions, new version of PDS 4.0[2] were adopted in data product from Chang'e 4 mission. The major adjustments are: 1) a dedicated detached XML label is used to describe the corresponding scientific data, a XML parsing framework is also designed to be provoked in the archiving procedure; 2) all images use an Array_2D_Image/Array_3D_Image object to store image data, and use a Table_Character object to store image frame header; all tabulated data uses a Table_Binary/Table_Character object to store measurements; 3) all classes, properties and their valid values and relationships used in labels are well-defined in a data dictionary for compliance inspection.

The scientific data products from Chang'e 4 mission are now under inspection, and necessary adjustments will be made according to the actual instrument performance. The first batch of Chang'e 4 scientific datasets will be released on http://moon.bao.ac.cn in the upcoming months.

References:

[1] Jiang, Y. Z. et al. (2018) Planetary and Space Science, 162, 207-215. [2] Besse, S. et al. (2018) Planetary and Space Science, 150, 131-140.