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# Data preprocessing and preliminary results of the moon-based ultraviolet telescope on CE-3 lander

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## Abstract

The moon-based ultraviolet telescope (MUVT) is one of the payloads on the Chang'e-3(CE-3) lunar lander. Because of the advantages of having no atmospheric disturbances and the slow rotation of the Moon, we can make long-term continuous observations of a series of important remote celestial objects in the near ultraviolet band, and perform a sky survey of selected areas. We can find characteristic changes in celestial brightness with time by analyzing image data from the MUVT, and deduce the radiation mechanism and physical properties of these celestial objects after comparing with a physical model. In order to explain the scientific purposes of MUVT, this article analyzes the pre-processing of MUVT image data and makes a preliminary evaluation of data quality. The results demonstrate that the methods used for data collection and preprocessing are effective, and the Level 2A and 2B image data satisfy the requirements of follow-up scientific researches.

## 1. Introduction

The moon-based ultraviolet telescope(MUVT) system is used to observe galaxies, binary stars, active galactic nuclei and bright stars. It is the first long-term observatory to be deployed on the Moon.

The MUVT system covers a wavelength range of 245 to 340 nanometers. It consists of a Ritchey-Chretien telescope(RCT). It uses a pointing mirror that features a two-dimensional gimbal to track objects.

The Chang'e-3(CE-3) lunar probe was launched on 2013 December 2 from the Xichang Satellite Launch Center. It made a successful soft landing on the Moon on December 14. The CE-3 probe landed in Mare Imbrium, 44 degree north of the lunar equator. The MUVT is mounted in the cabin–Y of the Lander. Therefore, the best option for the scientific observation is in a direction near north celestial pole.

From 2013 December 16 to now, a series of scientific explorations by the MUVT has been carried out in sequence, including: instrument calibrations, shafting observations that calculate the direction of the optical path in celestial coordinates, surveys, pointing observations.

## 2.Data preprocessing and preliminary results

The flowchart of the MUVT data preprocessing mainly includes the following steps: First, data communication channel processing includes: frame synchronization, Reed-Solomon decoding and optimized selection of two possible ground stations; Second, the frame data are compartmentalized and subcontracted; then, the extraction of the MUVT source packet data; label data from different Earth days into data blocks, after physical conversion; Level 2A data processing is related to instrument correction; level 2B data produce the results for processing related to identifying location.

The following mainly concerns with how the preprocessing method is related to level 2A and level 2B data products and preliminary results.

Because the moon-based ultraviolet telescope system works in the lunar day, and sunshine is the main source of stray light. To remove the contamination due to stray light is key. At first, we group images in each observational run by their pointing. The pattern of stray light in a given image is constructed by combining all the images(except the given image) in the group. Contamination from stray light is

subsequently removed from a given image by subtracting the constructed pattern of stray light.

On the ratio analysis of the starlight concentration, the target star, fitting the light distribution by a 1-dimensional Gaussian returns a FWHM of the pixels, which indicates that more than 80% energy is enclosed within 3 x 3 pixels for a point source.

The AB magnitude system is adopted by MUVT. Basing upon the observations of the standard star HD188665 (spectral type B5V) at the beginning the MUVT mission and the date reduction described above, we obtained a preliminary results on the magnitude zero point of Z=17.49 ± 0.02 mag, in which the error corresponds to 1sigma significance level and is obtained from multiple observations. Fig. 1 shows the results in the condition that a goal star is repeated sampling with the same aperture and the parameters. The magnitude diffusion of 1 σ by aperture photometry is 0.06 magnitude.

## 3. Figures

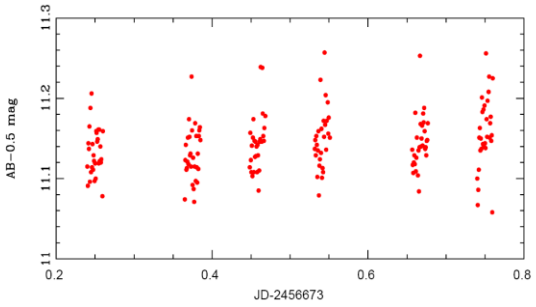


Figure 1: The dispersion analysis for the target by multiple sampling.

## 6. Summary and Conclusions

The MUVT is one of the payloads equipped on the lander. This is the first time the continuous monitoring of important optical variables and surveys of an area with low galactic latitude have been performed. It has worked at least half and one years in accordance with the design life of the instrument on the Moon. The MUVT operates in three modes: standby mode, the state of being powered on but not collecting data; adjusting mode, the state where adjustments and pointing are made; detection mode, saving data received while the device is operating. Through the analysis of data products from the first and second lunar days, instrument correction and stray light reduction are performed for all images, so the effects of the instrument and stray light are effectively removed. According to the results of data analysis, the instrument could observe magnitude 13 stars(with an SNR of 5) in a 30s exposure during the Moon's twilight period. However, at about lunar noon, due to the interference of stray light from the sun, the observation capacity is reduced to about magnitude 11(with an SNR of 5). The preprocessing method is reasonable and the data products are effective. All data products can be used as the data base of scientific research on ultraviolet astronomical observation.

## Acknowledgements

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