EPSC Abstracts
Vol. 5, EPSC2010-224, 2010
European Planetary Science Congress 2010

Global brightness temperature of the Moon: result from Chang'E-1 microwave radiometer

Yong-Chun Zheng (1), Y. L. Zou (1), K. L. Chan (2), K. T. Tsang (2), B. Kong (2), and Z. Y. Ouyang (1)
(1) National Astronomical Observatories, Chinese Academy of Sciences, Beijing, China, (2) Centre for Space Science Research, Hong Kong University of Science and Technology (zyc@nao.cas.cn / Fax: +86-10-64807920)

Abstract

This paper introduced the brightness temperature data sets of the Moon, which is observed by Chang'E-1 microwave radiometer. The global brightness temperature maps were presented.

1. Introduction

Using remote sensors, human beings had obtained the gamma-ray, X-ray, ultraviolet, visible and infrared picture of the Moon in the in the electromagnetic (EM) spectrum. These EM emission characteristics were used to derive the composition of surface materials, topography and geologic structures of the Moon. However, the microwave picture of the Moon has long relied on the observation by earth-based radio telescope at observatories. The astronomers have few interests for the observation of such near celestial body. The most observation case study was mainly occurred at pre-and post Apollo era.

2. CE-1 Microwave Radiometer

Chang'E-1 (CE-1) is the first Chinese lunar orbiter, which was launched in 24th, Oct. 2007. One set of four channels microwave radiometer (MRM) was boarded on Chang'E-1 to map the moon at microwave band. Different from the principle by active radar system, MRM is a passive remote sensor. CE-1 MRM was designed to measure the microwave emission of the Moon at the frequency of 3.0, 7.8, 19.35 and 37 GHz (Table. 1). The measurement results could be produced into the brightness temperature (TB) data sets.

Table 1: Major technical parameter of CE-1 MRM

Instrument/Experiment	CE-1 MRM
Frequencies	3.0, 7.8, 19.35 and 37 GHz
Integration time	200(±15%) ms
Temperature Resolution	⩽0.5 K
Linearity	⩾0.99
Footprint	56km for 3.0GHz and 30km for other three channels

3. TB Data Sets

Microwave radiation of the Moon is a kind of thermal radiation. For longer wavelength than infrared and visible bands, microwave radiation could penetrate several centimeters to more than ten meters in lunar regolith. Therefore, TB data sets could be used to derive the physical properties of lunar regolith layers, such as temperature, layered structure and composition. In the 482 day's span life of CE-1, MRM has obtained TB data sets with eight times global-coverage. Data amount of level 0, level 1 and level 2 are 30,272MB, 17,206MB, 1,334MB, respectively. These TB data sets give us a chance to know a new Moon in the microwave band, which is much different from UV-VIS-IR band.

4. TB Maps

Global day-time TB map (Fig. 1) and night-time TB map (Fig.2) of the Moon have been produced.

5. Summary and Conclusions

From these TB maps, we can summarize as:

1). By earth-based radio observation, only the nearside of the Moon could be seen. Because of the edge effects of the sphere body, only TB of the region near the center of the disk could be credible. When close to the edge of the disk, the spatial resolution and the accuracy of the observation were becoming worse (Fig. 3). CE-1 MRM has not only completed global coverage in space, but also cover the day-time and night-time of the Moon. Thus we can see the lunar surface in the dark night, which is

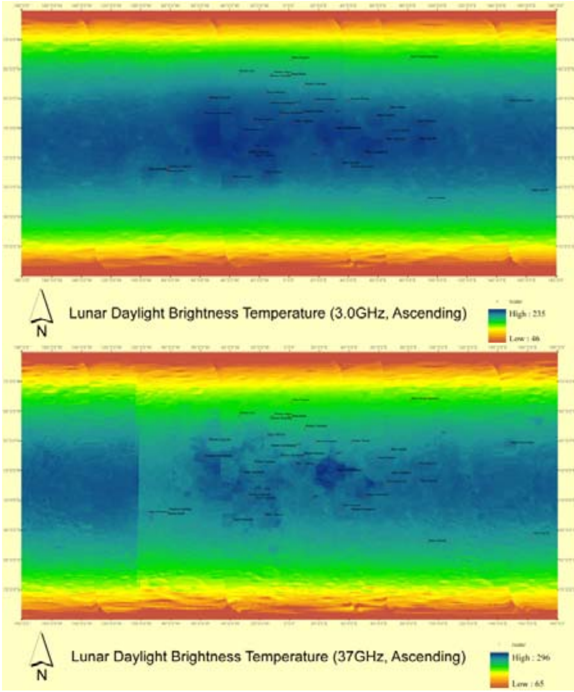

Figure 1: Global day-time TB map of the Moon.

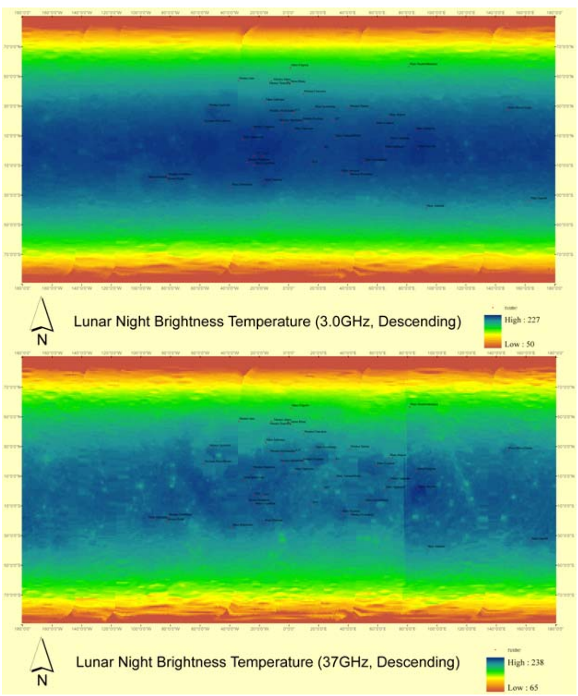

Figure 2: Global night-time TB map of the Moon.

not illuminated by the Sun. The observation by CE-1 MRM has also avoided the influence of the atmosphere in the earth-based observation, and obtained temperature resolution less than 0.5K. Footprint of the CE-1 MRM observation is 56km for 3.0GHz and 30km for other three channels, from 200km altitude. It means that the spatial resolution is improved significantly than earth-based observation.

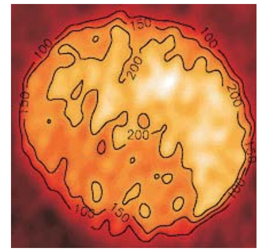

Figure 3: TB map of the Moon at 5.7GHz, observed by the Siberian Solar Radio Telescope (SSRT).

2). Whether in the day-time or night-time, the boundaries between mare and highland, and the contour the crater could be identified in the 37GHz TB map. It suggests that the microwave radiation at higher frequency was mainly contributed by lunar surface materials, which is controlled by solar radiation. While in the 3.0GHz TB map, the mare-highland boundaries and carter’s contour were difficult to be identified. It suggests that the microwave radiation at lower frequency was contributed by the radiation from lunar surface and deeper layers.

3). It is shown that the diurnal variation of TB in 3GHz is several times less than that in 37GHz. The former is about 10K, and the later is about 50K. Dark mare is hotter than highland regions, which is accounted for more abundant loss materials, mainly ilmenite in the mare.

4). We have discovered about 200 cold spots in the nearest publication [1]. We also believe that the thickness of lunar regolith layer and the heat flow of the Moon can be retrieved from the TB data sets. The former result could be used to estimate the resource amount of helium-3. The later result is very important for the study of inner energy of the Moon.

Acknowledgements

This work is supported by a grant from 863 Program and the National Natural Science Foundation of China (No. 40904051).

References

[1] Chan, K.L., Tsang, K.T., Bruce, Kong., and Zheng, Y. C.: Lunar regolith thermal properties revealed by Chang'E-1 microwave brightness temperature data, Earth and Planetary Science Letters, 10.1016/j.epsl.2010.04.015.