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EXPLORING THE MOON FROM NON-MOON ORBIT SPACECRAFT

Abstract

Purpose: The exploration of the Moon from the ground was strongly influenced by the atmosphere, and from the lunar orbit cannot image the whole Moon in a single exposure. Comparatively, the observation from the Earth's orbit such as geostationary satellite or space station has the merits of no atmosphere and imaging the whole disk in a single exposure. The Moon's optical characteristics in visible and thermal infrared have long been observed. However, what the mid-infrared (MIR) Moon looks like is still a mystery. For the first time we show the MIR Moon imaged by China's high-resolution geostationary satellite (GF-4). Methodology: GF-4, part of the China High-resolution Earth Observation System (CHEOS), has a large-array VNIR detector and an MIR detector. The entire lunar disk was imaged in both VNIR and MIR in a single exposure with spatial resolutions of up to 500 m/pixel and 4 km/pixel, respectively. Such high-resolution single-exposure images are advantageous for investigating the brightness/temperature distribution across the lunar disk compared to a mosaic of image frames. Results: the Moon in MIR appears inverted compared to its image in VNIR. On the MIR lunar disk, maria become brighter than the highlands, and the high albedo features become darker than their surroundings. The Moon in the MIR exhibits limb darkening and shows a diminished contrast. In contrast, topographies are obvious. These features indicate that at MIR wavelengths both the reflected sunlight and the thermal emission from the Moon itself are significant. The brightness temperature is approximately concentrically distributed around the sub-solar point. The warmest location follows the Sun and is not exactly at the sub-solar point but in the nearby mare. The relationship between brightness temperature and solar incidence angle i is cos1/bi, and the power parameter is smaller than the Lambertian temperature model. The slower decrease of the brightness temperature when moving away from the sub-solar point than the Lambertian model is due to topographic effects. Conclusion: The MIR Moon are controlled by both the reflection and emission of the lunar surface. The brightness temperature is dominated by albedo and the solar incidence angle and influenced by the topography. Discussion: The Moon in the MIR exhibits many interesting phenomena which were previously unknown and contains abundant information about lunar reflection and thermal emission for future study. The exploration of the Moon from non-Moon orbit is very useful.