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GCR Corrections of the Lunar Gamma-Ray Spectra

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Abstract

The gamma-ray emission from the Moon is initiated by the interactions of the Galactic Cosmic Rays (GCRs) with various elements near the lunar surface. In this presentation, we show we analyse the gamma-ray spectral data acquired during the Chinese Chang'E-1 lunar mission. We focus specifically on removing from the Chang'E-1 observations the time variability inherent in the incident GCR fluxes. This is based on the count rates in the 6.13 MeV oxygen line, since this element tends to be uniformed distributed across the lunar surface and is a good diagnostic of the intrinsic variation in GCR flux. Possible contamination by spacecraft thrusters firings is also discussed.

1. Introduction

The gamma-ray emission from the Moon is initiated by the interactions of the Galactic Cosmic Rays (GCRs) with various elements near the lunar surface (e.g., Fe, Ti, O,Mg and et al.). To obtain the global distribution of these elements on the Moon, the gamma-ray spectra initiated by many different GCRs flux have to be combined. Since GCRs are highly variable, one key aspect of the analysis of the gamma-ray spectra is to remove such variability over the period when the data were acquired. This ensures that the corrected gamma-ray spectra reflect the intrinsic variations in the element abundance on the Moon. To correct for the time variability of GCRs, we use the 6.13 MeV oxygen line in the lunar gamma-ray spectra, since the abundances of this element tend to be uniformly distributed over the Moon [2].

2. How are the O lines in the lunar gamma-ray spectra affected by spacecraft thruster firings?

One potential contamination to the O lines in the lunar gamma-ray spectra is the consumption of the oxidant fuels of CE-1, which mostly occurs during spacecraft maneuvers[4]. To investigate this, we compare in Figure 1 the intensities of the 6.13 MeV O line both before and after the spacecraft orbit maintenance. A similar comparison before and after the spacecraft attitude trim is provided in Figure 2. Both figures reveal that the variations in the intensity of the 6.13 MeV oxygen are insignificant and could be ignored.

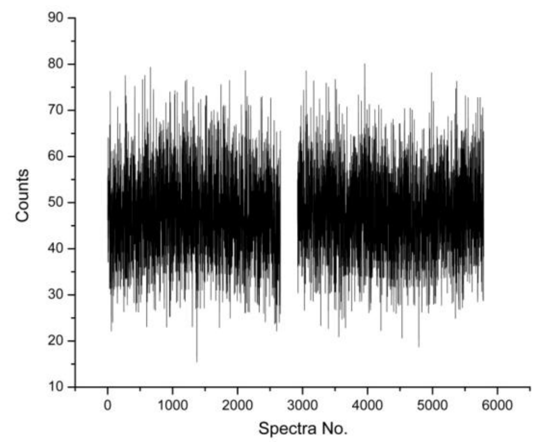

Figure 1: Variation of the 6.13 MeV oxygen line before and after the spacecraft orbit maintenance

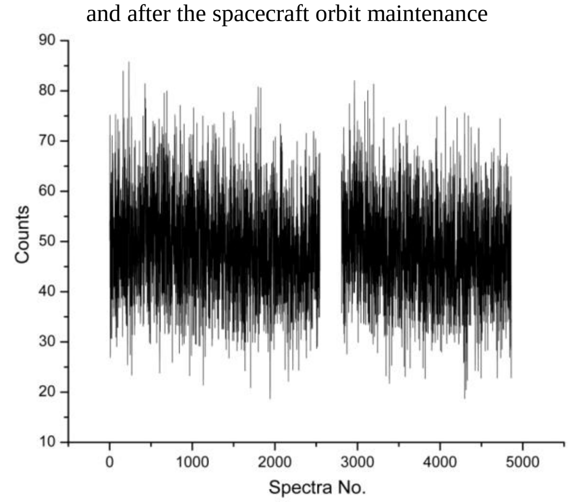

Figure 2: Variation of the 6.13 MeV oxygen line before and after the spacecraft attitude trim

2. The methods of GCR correction of the lunar gamma-ray spectra

In order to correct for GCRs in the lunar gamma-ray spectra, we smooth the 6.13 MeV counting rates over 127 minutes (corresponding to an entire orbit of CE-1), which are then normalized to the value obtained at the beginning of the mission on December 29th, 2007. A linear scaling relation is assumed[3].

3. Results and Conclusions

Figure 3 shows the uncorrected counts of the lunar gamma-ray spectra averaged between 300 keV and 9 MeV obtained from the 556th to 705th CE-1 orbits. The counts corrected for GCR variability are shown in Figure 4 for comparison.

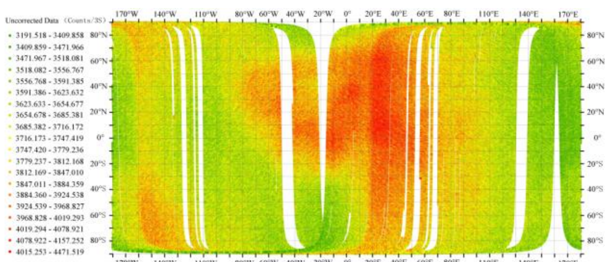

Figure 3: The distribution of the uncorrected GCR counts

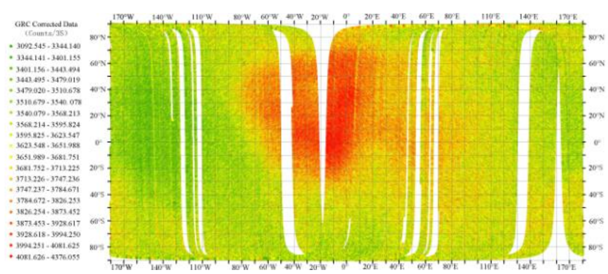

Figure 4: The distribution of the corrected GCR counts

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