Simultaneous physical retrieval of daytime lunar surface temperature and spectral emissivity in the 3–5 μm range from Chandrayaan-2 IIRS observations

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The Imaging InfraRed Spectrometer (IIRS) on board Chandrayaan-2 has been providing high spatial and spectral resolution observations of the lunar surface in 256 spectral bands (0.7–5 μm) since September 2019. It is primarily intended for mineral mapping and identifying hydration features on the lunar surface using reflectance spectra in the range of 0.7–3.2 μm. Here, we have used the IIRS observations in the 3–5 μm range to retrieve daytime lunar surface temperature and spectral emissivity using an optimal estimation theory-based retrieval algorithm. The surface temperature is retrieved at every pixel, while spectral emissivity is retrieved at every third pixel of the hyperspectral image. The mean uncertainty of the retrieved spectral emissivity varies from 0.04 to 0.08, while for surface temperature, it is about 3.5 K. The retrieved spectral emissivity is found to be in close agreement with the emissivity of the Apollo-16 return soil samples.

Keywords: Hyperspectral imaging, lunar exploration mission, optimum estimation, retrieval algorithm, spectral emissivity, surface temperature.

The lunar surface temperature can be retrieved by the inversion of surface-emitted radiance observations. As surface-emitted radiance is a function of surface emissivity, its value must be known for the inversion of lunar surface temperature. Since the lunar surface emissivity is not yet available at the global scale, it is assumed to be fixed in a defined range prescribed by various researchers[5–8]. However, as the lunar surface is known to have spatial compositional variations, a fixed emissivity value is not a correct assumption. It may lead to some uncertainties in applying T_s, such as comparing daytime and night-time surface temperatures, and the calculation of surface energy balance[9]. To achieve accurate physical lunar surface temperature, the effect of emissivity must be removed from the radiance observations.

A global dataset of lunar surface temperature retrieved from Diviner Lunar Radiometer Experiment (DLRE, also referred as Diviner), onboard the Lunar Reconnaissance Orbiter (LRO), observations is available at 0.5° spatial and 0.25 h temporal resolution[10]. Ren *et al.*[9] derived the lunar surface temperature and emissivity from the Diviner