ONC-T/Hayabusa2の感度校正とリュウグウUV観測の展望

Sensitivity calibration of ONC-T/Hayabusa2 and importance of UV observation on Ryugu

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ONC system onboard Hayabusa2 is planned to observe the morphology and photometry of the target asteroid Ryugu (1999JU3). The C-type asteroid Ryugu is expected to have organic compounds and hydrated minerals which may have affected greatly the environment of the Earth in the early Solar System. One of the important objective of the Hayabusa2 is to trace the hydrated minerals and reveal the thermal history of Ryugu because the presence of hydrated minerals suggests once the asteroid was warm enough to possess liquid water. The 3 micron absorption is the most prominent feature to show the presence of OH, which will be detected by the near-infrared spectrometer NIRS3 which is also onboard Hayabusa2. However, the spatial resolution of NIRS3 is more than 10 times larger than ONC-T. Thus, it is very important to map the hydrated minerals by ONC-T with high resolution ~2 m/pixel and see some relationship with the geological features which can be also observed by ONC. There are two widely known proxies for hydrated minerals in UV to visible wavelength, 0.7-micron and UV absorptions, which are attributed to charge transfer transition processes (Vilas and Sykes, 1996). In this study, we focus on the UV feature of asteroids and discuss the possible implication from the UV observation of Ryugu by ONC-T.

First, we examined the asteroid UBV reflectance database collected by Tedesco (1995). Only 3-band spectroscopy can classify the S- and C-types clearly. Moreover, we plotted the B-, C-, F-, G-, and P-types on the B/U and V/B space, and it is found that these taxonomic types are weakly classified in this space. More aqueous altered asteroids, such as G- and C-types, shows larger B/U ratio, which means more absorption in U band. This is consistent with the correlation of the strength of 3-micron and UV absorptions (Freierberg et al., 1985). Thereby, we may map the degree of aqueous alteration on Ryugu by UV absorption observed by ONC-T.

Second, the SDSS Moving Object Catalog which includes u’ - (0.36 μm) and g’ - (0.48 μm) filter radiances is examined to characterize the potential families of Ryugu by UV feature. The UV slope obtained by g’/u’ suggests significant difference between Nysa-Polana family and Erigone family, while values of Erigone family and Salmitis family are similar. Thus, we may distinguish the family of Ryugu by the UV observation.

The ONC system is constituted of three CCD cameras, and one of the camera ONC-T loaded seven bandpass filters from UV to NIR wavelength, u: 0.40 μm, b: 0.45 μm, v: 0.55 μm, Na: 0.59 μm, w: 0.70 μm, x: 0.86 μm, and p: 0.95 μm. For UV observation, the calibration of u-, b-, and v-filters is important. We conducted seven star observations during the cruising phase in order to measure the sensitivities for filter bands. Seven stars were selected from the Southern Europe Observatory standard star database and Alekseeva et al. (1994). We measured the intensity of the stars after the bias, dark and background subtractions. The sensitivities of u-, b-, and v-bands are obtained with the error <5%. Moreover, we also examined the sensitivity uniformity over the FOV using star observations. Using those obtained sensitivities, the lunar reflectance spectra are also examined. We compare the lunar spectra obtained during the Earth gravity swing-by and the LROC/WAC model spectrum (Sato et al., 2014). The normalized reflectance b/v shows very good match with error of ~1%, but the reflectance ul/v shows relatively larger error of ~10%. This could be explained by the difference in the calibration method in which the WAC used the Apollo samples as the reference spectra but not the lunar telescopic observation spectrum itself. Finally, we plan to observe the first light of Ryugu at the end of February. Due to the faintness of Ryugu, the read-out noise and shot noise yield the signal-to-noise ratio ~1 for the ul-band single image, which is not enough to distinguish the families or classes. However, the signal-to-noise ratio will be ~100 and the observed spectra may imply the family and the condition of aqueous alteration from UV observation, once Hayabusa2 approaches Ryugu closely enough <50000 km.

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