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Spectroscopic observations of asteroid 21 Lutetia over the 3-micrometer region by AKARI satellite

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M-type asteroids have been interpreted to be fragments of the metallic cores of differentiated asteroids based on high albedos (0.15-0.25) and red-sloped featureless spectra. However, two of them, 55 Pandora and 92 Undina, were found to have the evidence of hydrated materials (i.e., strong 3-micrometer absorption bands). Because hydration usually occurs by aqueous alteration of minerals in asteroids, the presence of hydrated materials on M-type asteroids contradicts the interpretation of M-type asteroids as disrupted cores of differentiated bodies. However, if water was present long enough to metamorphose high-temperature anhydrous minerals, hydrated minerals may be formed on differentiated bodies.

Asteroid 21 Lutetia is categorized as a typical M-type asteroid. While the reflectance spectrum of the surface of 21 Lutetia was initially found to have 3-micrometer absorption, a recent observation showed a very shallow or no 3-micrometer absorption band. Thus, the presence of 3-micrometer absorption bands of 21 Lutetia is still unclear. The spectrum of 21 Lutetia over the 3-micrometer region needs to be observed. However, the spectra in the wavelength region between 2.6 and 2.8 micrometers cannot be easily observed with ground-based telescopes because of the strong absorption of H2O in the telluric atmosphere. Thus, observation in space, which is not affected by the telluric absorption, is extremely useful for obtaining data in the wavelength region including 2.6-2.8 micrometers. The purpose of this study is to investigate whether the 3-micrometer absorption exits in the spectrum of 21 Lutetia obtained by the Japanese infrared satellite AKARI.

AKARI, the first Japanese satellite for infrared astronomy, was launched on 2006 February 21 UT. A grism spectrograph with the 1'x 1' aperture was used for obtaining the reflectance spectra of the asteroids between 2.5 and 5 micrometer with a spectral resolution of 0.097 micrometer/pix. 21 Lutetia was observed in twice as shown on 2008 September 2 UT. These data are processed through the IRC Spectroscopy Toolkit for Phase 3 data (version 20090211) with the new spectral responsively (version 20110301).

Two observational data (IDs 1520157 and 1520158) and their average spectrum seem flat between 2.6 and 3.6 micrometer, especially over the 3-micrometer band range. Acquisition of the spectral portion over the wavelength range from 2.6-2.8 micrometer, where ground-based telescopic observation is extremely difficult, has become possible using AKARI. We compare our spectra with those of previous studies. The spectrum 1520157 is analogous to the 2007 and 2008 spectra in Fig. 1 of [1] over the range of 2.85-3.50 micrometer within 10% difference. Both of them are blue-sloped in the range of 2.85-2.9 micrometer and a little red-sloped beyond 3.3 micrometer. The spectrum 1520158 is analogous to the 2003 spectrum in Fig. 1 of [1] over the 2.85-3.50 micrometer range within 5%. Both spectra exhibit a shallow absorption band at 3.2 micrometer and a feature around 3.5 micrometer. Additionally, the spectra 1520157 and 1520158 are analogous to the 2007 and 2008 spectra in Fig. A5 of [2] over the 2.85-3.50 micrometer range within 5% and 10%, respectively.

We investigated whether the presence of 3-micrometer absorption band of 21 Lutetia. If the lowest reflectance and error in observation over the wavelength range from 2.55-2.60 micrometer is higher than the highest reflectance and error in observation over the wavelength range of 2.70-2.80 micrometer, we consider that absorption band exists. As a result, the reflectance spectrum has a very shallow or no obvious absorption band around 3-micrometer. Such observation of 3-micrometer band will help us understand the nature of M-type asteroids.

[1] Rivkin A. S. et al. (2011) Icarus, 216, 62-68. [2] Vernazza P. et al. (2011) Icarus, 216, 650-659.

Keywords: AKARI, asteroid, 21 Lutetia, hydrated mineral, thermal history