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Main-Belt Infrared Spectral Analogues for (101955) Bennu: AKARI and Spitzer IRS Asteroid Spectra

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Abstract

The Origins, Spectral Interpretation, Resource Identification, Security–Regolith Explorer (OSIRIS-REx) mission has measured the spectrum of asteroid (101955) Bennu in reflectance (OVIRS instrument; [1]) and thermal emission (OTES instrument; [2]). Here we place the global average spectra of Bennu [3] in the context of the wider asteroid population as represented by infrared reflectance spectra from the AKARI mission [4] and thermal emission spectra from the Spitzer Infrared Spectrometer [5].

1. Main-Belt Analogues for Bennu

(101955) Bennu has been considered most likely to have originated in the inner-Main-Belt families of (495) Eulalia (C-type, a = 2.49 AU) or (142) Polana (B-type, a = 2.42 AU) [6]. Regrettably, neither Eulalia nor Polana nor their family members were observed spectroscopically either with AKARI or with the Spitzer IRS.

1.1 B-type Main Belt asteroids in the AKARI spectral catalogue

(2) Pallas, (704) Interamnia, and (24) Themis were observed spectroscopically by AKARI. Although all three asteroids are dynamically distant from the Polana/Eulalia complex and the ν_6 secular resonance, Pallas and Interamnia are close spectral matches in the 2.6–3.5 μm wavelength region, in which Bennu's strongest spectral feature is located (Figs. 2 and 3). Bennu's 2.7-μm band is weaker than that of Pallas by a factor of approximately 2 and weaker than that of Interamnia by a factor of 1.4. The shape of the band is a closer match to that of Pallas in the 2.85–3.0 μm region.

(24) Themis is a comparatively poor match to Bennu in this region, as it contains a deep 3.1-μm band not matched by corresponding structure in Bennu's spectrum (Rivkin and Emery 2010, Campins et al. 2010).

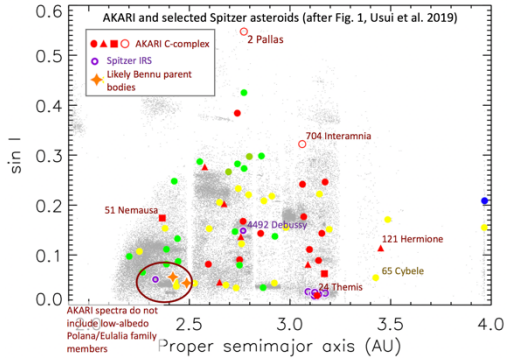

Figure 1: Dynamical context of AKARI and selected Spitzer asteroids in the asteroid main belt

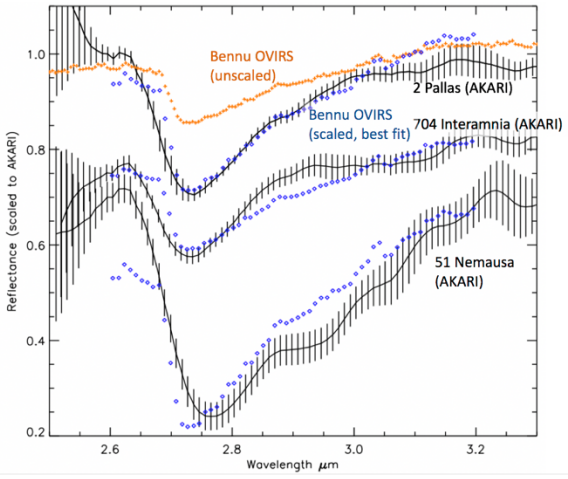

Figure 2: OVIRS spectrum of Bennu vs. AKARI spectra of B-type asteroid (2) Pallas, B- or Cb-type asteroid (704) Interamnia, and inner-main-belt Cgh-type asteroid (51) Nemausa

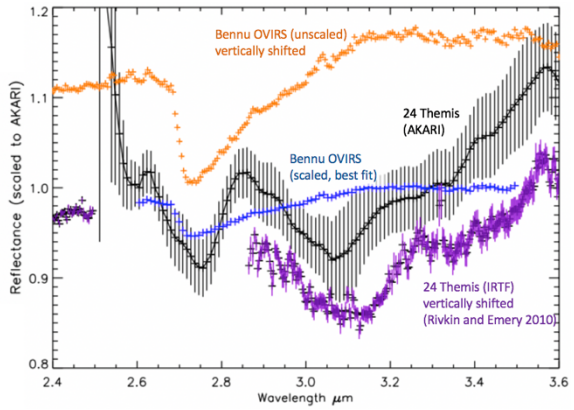

Fig 3: OVIRS spectrum of Bennu vs. AKARI and groundbased spectra of B- or C-type asteroid (24) Themis

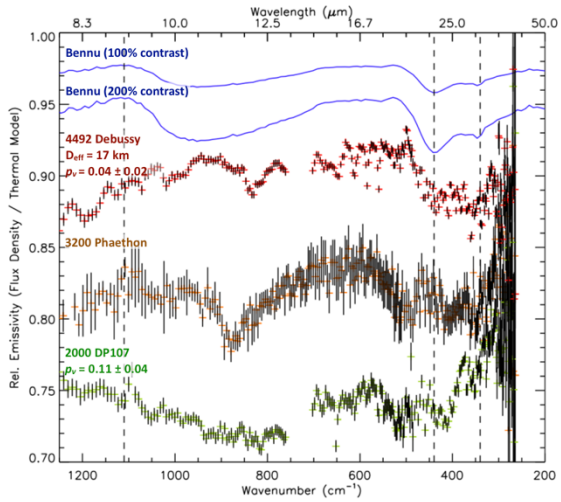

Figure 4: OTES spectrum of Bennu with spectra of (4492) Debussy (a = 2.77 AU; D_{eff} = 17 km), B-type NEO 3200 Phaethon (D ≈ 5 km) and the sub-kilometer top-shaped asteroid NEO 2000 DP107 [8]

1.2 Spitzer IRS asteroid spectra

Emissivity spectra for several low-albedo binary asteroids have been published [8]. Among these, the spectrum of (4492) Debussy is the closest match to that of Bennu in the 20–30 μm region but is dissimilar in the 8–14 μm region, with a narrow emissivity minimum at 12 μm that is absent from the spectrum of Bennu. Debussy was classified as a C-type by Dandy *et al.* (2003). A low Bennu-like density was reported for Debussy (ρ = 0.9 ± 0.1 g/cm^3).

2. Summary and Conclusions

Although dynamically distant from the most likely Bennu source regions in the main belt, (2) Pallas is a close spectral analogue to Bennu in the 2.6–3.2 μm region. There are no Spitzer IRS spectra of Pallas or its family members.

Bennu's thermal-IR spectrum is unlike those of "10-μm plateau" main-belt and Trojan low-albedo objects, including the B-type asteroid (24) Themis and its large family members. Thus, the low-thermal-inertia boulders that dominate the surface of Bennu are not producing the same spectral emissivity behavior that has been attributed to underdense fairy-castle surface structure in these larger objects (e.g. [7]).

Themis is also not a close spectral match in the 2.5–3.5 μm region.

Small B-type family members in the main belt have not yet been spectrally characterized in the thermal IR. Measurements of small Polana/Eulalia family members in the main belt would be the most directly relevant to the origin of Bennu.

Acknowledgements

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