MAIN-BELT INFRARED SPECTRAL ANALOGUES FOR (101955) BENNU: GAUSSIAN FITTING TO AKARI SPECTRA OF BENNU-LIKE ASTEROIDS. L. F. Lim[1], H. H. Kaplan[2], V. E. Hamilton[2], P. R. Christensen[3], A. A. Simon[1], D. C. Reuter[1], J. P. Emery[4], B. Rozitis[5], M. A. Barucci[6], A. Praet[6], H. Campins[7], B. E. Clark[8], M. Delbo[9], J. Licandro[10], R. D. Hanna[11], S.A. Sandford[12], E.S. Howell[13], D. S. Lauretta[13], [1]Goddard Space Flight Center, Greenbelt, MD, USA (lucy.f.lim@nasa.gov), [2]Southwest Research Institute, Boulder, CO, USA, [3]Arizona State University, Tempe, AZ, USA, [4]University of Tennessee, Knoxville, TN, USA, [5]Open University, Milton Keynes, UK, [6]LESIA, Paris Observatory Meudon, France, [7]University of Central Florida, Orlando, FL, USA, [8]Ithaca College, Ithaca, NY, USA, [9]CNRS, France, [10]Instituto de Astrofísica de Canarias, Tenerife, Spain, [11]University of Texas, Austin, TX, USA, [12]Ames Research Center, Mountain View, CA, USA.[13]Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ, USA.

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

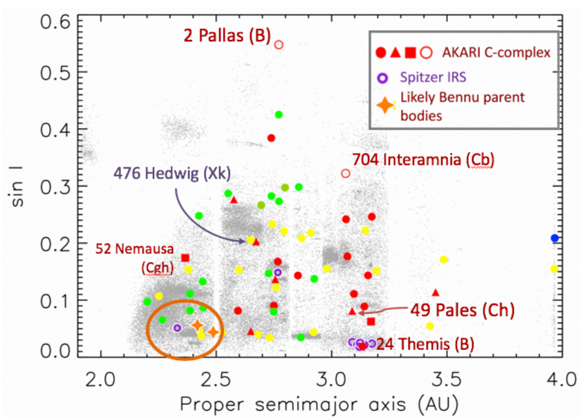

Figure 1: Dynamical context of AKARI and selected Spitzer asteroids in the main belt relative to the probable Bennu source region (orange ellipse). Asteroids with Bennu-like spectral shapes in the 2.6–3.5 µm region can be found at a wide range of semimajor axes and inclinations.

On dynamical grounds (101955) Bennu has been considered most likely to have originated in the inner main belt families of (495) Eulalia (C-type, semimajor axis a = 2.49 AU) or (142) Polana (B-type, a = 2.42 AU) [5] (Fig. 1). However, neither Eulalia, nor Polana, nor their family members were observed spectroscopically either with AKARI or with the Spitzer IRS.

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 relatively 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) [3].

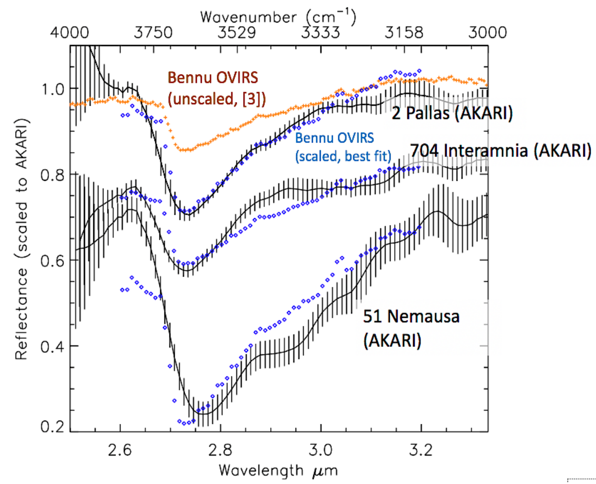

Fig. 2: OVIRS spectrum of Bennu vs. AKARI spectra of B-type asteroid (2) Pallas, B- or Cb-type asteroid (704) Interamnia, and inner-main-belt Cgh-type asteroid (51) Nemausa

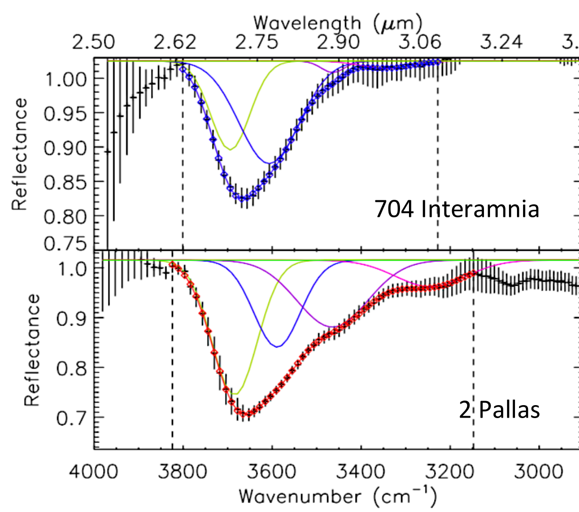

Figure 3: Preliminary four-Gaussian fits to the AKARI spectra of (2) Pallas and (704) Interamnia. The Gaussian at ~2.9 µm is much stronger in the spectrum of Pallas as a fraction of the total band area. Gaussian deconvolutions following Hiroi et al. 2018, 2019; Kaplan et al. 2019 [6, 7]

Like Bennu, Pallas and Interamnia both have band minima at $\lambda_{2.7}$ = 2.74 ± 0.01 µm [3, 4]. The shape of

Bennu's 2.7-µm band is a substantially better match to that of Pallas in the 2.85–3.0 µm region. Preliminary Gaussian fits (Fig. 3) show that the difference in shape can be explained by the size of the Gaussian at ~2.89 µm. See Praet et al. (2020) for Gaussian fits to the OVIRS spectrum of Bennu [8].

In contrast, B-type (24) Themis is a comparatively poor match to Bennu in this region and also contains a deep 3.1-µm band [9,10] not matched by corresponding structure in Bennu's spectrum.

Other C-complex and Xk-type Main Belt analogues to Bennu: Several other asteroids in the AKARI catalog are similarly close spectral matches to Bennu based on a combination of χ^2 and correlation tests. (476) Hedwig is notable for the similarity of its spectral shape (Figs. 4, 5) in spite of its VNIR classification as an Xk or P-type asteroid rather than a member of the C-complex.

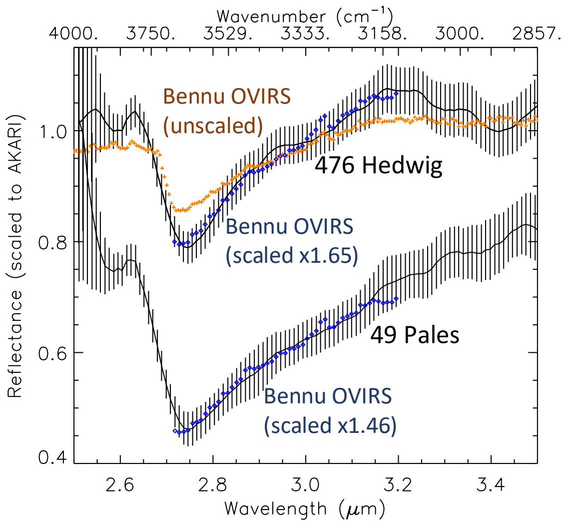

Figure 4: Bennu-like band shapes in Xk-type asteroid 476 Hedwig and Ch-type outer-main-belt asteroid 49 Pales

We note that as with (24) Themis, there are also many C-type objects that are very unlike Bennu in the 2.7-µm region, such as (94) Aurora, (52) Europa, and (451) Patientia. The Xc-type (21) Lutetia, despite being a member of the low-inclination inner-main-belt population, is also not an analogue to Bennu in this spectral region.

Summary and Conclusions: Spectral analogues to Bennu in the 2.6–3.2 µm region are widespread among the large main-belt asteroids in the AKARI catalogue and are commonly dynamically distant from the most likely Bennu source regions in the main belt. Pallas is a close spectral analogue to Bennu in spite of its high inclination. At the AKARI spectral resolution, the Bennu-like spectral shape can be represented by four

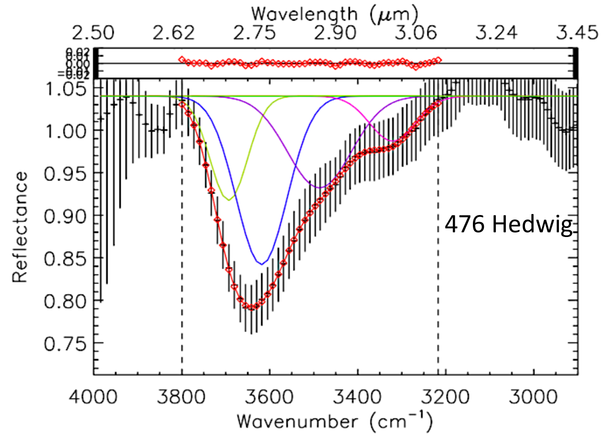

Figure 5: Four-Gaussian fit to the AKARI spectrum of Xk-type asteroid 476 Hedwig. As with the fit to (2) Pallas, the Gaussian close to 2.9 µm represents nearly 30% of the total band area.

Gaussians, one of which falls close to 2.89 µm and represents a substantial fraction of the total band area.

Further observations, likely space-based, will be needed in order to determine whether this spectral shape is prevalent among the main-belt populations with the most straightforward dynamical pathways to Bennu-like orbits: the low-inclination inner-main-belt C-complex asteroid families, or the low-inclination inner-main-belt population more generally.

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