



SPECTROSCOPY OF THE BINARY TNO MORS-SOMNUS WITH THE JWST AND ITS RELATIONSHIP TO THE COLD CLASSICAL AND PLUTINO SUBPOPULATIONS OBSERVED IN THE DISCO-TNOS PROJECT

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MORS-SOMNUS: PHOTOMETRIC PROPERTIES

- Only binary pair spatially resolved in the DiSCo-TNO (JWST large program - cycle 1 - GO 2418) sample (Souza-Feliciano et al., 20204).
- Ultra-red visible spectral slope: $36 \pm 2 \text{ \%}/1000 \text{ \AA}$ (Sheppard et al., 2012).
- Difference in 0.1 magnitude and separation of $21\,000 \pm 160 \text{ km}$ between the pair (Sheppard et al., 2012).
- Parameters estimated through Light Curve (Thirouin et al., 2014): $< 116 \text{ km}$ (Mors) and $< 110 \text{ km}$ (Somnus), albedo > 0.12

MORS-SOMNUS: DYNAMIC BACKGROUND

- Shepard et al., 2012: cold classical pair transported to the 3:2 resonance early in Solar System history.
- Nesvorný & Vokrouhlický (2019): Mors-Somnus wouldn't survive this process!
- Instead, it formed as the cold classical TNOs after 30 au (Nesvorný, 2015) and were transported by gentle processes to the 3:2 mean motion resonance with Neptune (Hahn & Malhotra, 2005).

GOALS

- To characterize the surface composition of the pair using JWST/NIRSpec resolved observations.
- To use the surface composition of the individual components of the Mors-Somnus system to probe formation and dynamical evolution in the outer solar system through comparison with cold (2003 GH₅₅, Sila-Numan, Kágára, 2001 QD₂₉₈, and Borasisi) and plutino (2007 JF₄₃, Lempo, Huya, 2004 EW₉₅, 2003 UZ₄₁₃, and 2002 XV₉₃) dynamical classes of the DiSCo-TNOs sample.

OBSERVATIONS AND DATA REDUCTION

The details of the observations and the data reduction can be found in the published paper.



ANALYSIS & RESULTS: MORS-SOMNUS

The spectrum of each component of the binary pair can be seen in Figure 1.

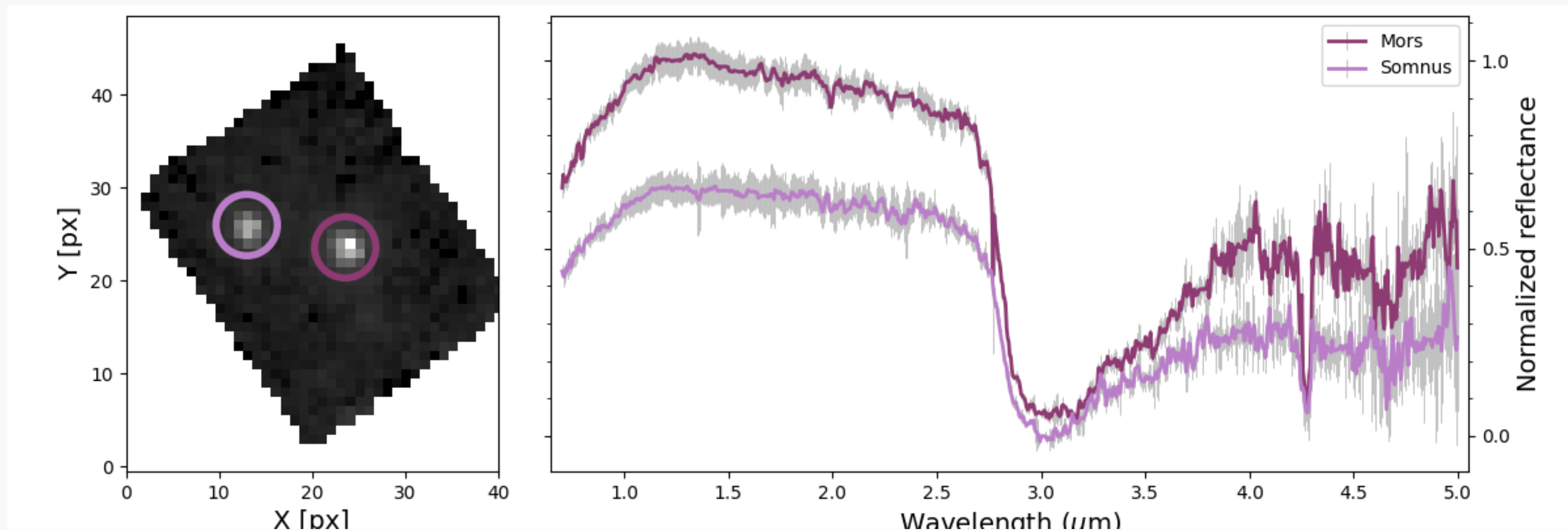


Fig. 1 – Spectral data cube and near-infrared spectra of Mors–Somnus. Left: A single slice of the spectral data cube obtained by the NIRSpec IFU showing the resolved Mors (primary – dark purple circle) and Somnus (secondary – light purple circle) TNO binary system. Right: Normalized reflectance of Mors at 1.25 μm (dark purple line) and Somnus reflectance scaled to Mors (light purple line) versus wavelength (μm). The 1σ uncertainties are represented by the light gray bars.

MORS-SOMNUS: SPECTRAL CHARACTERIZATION

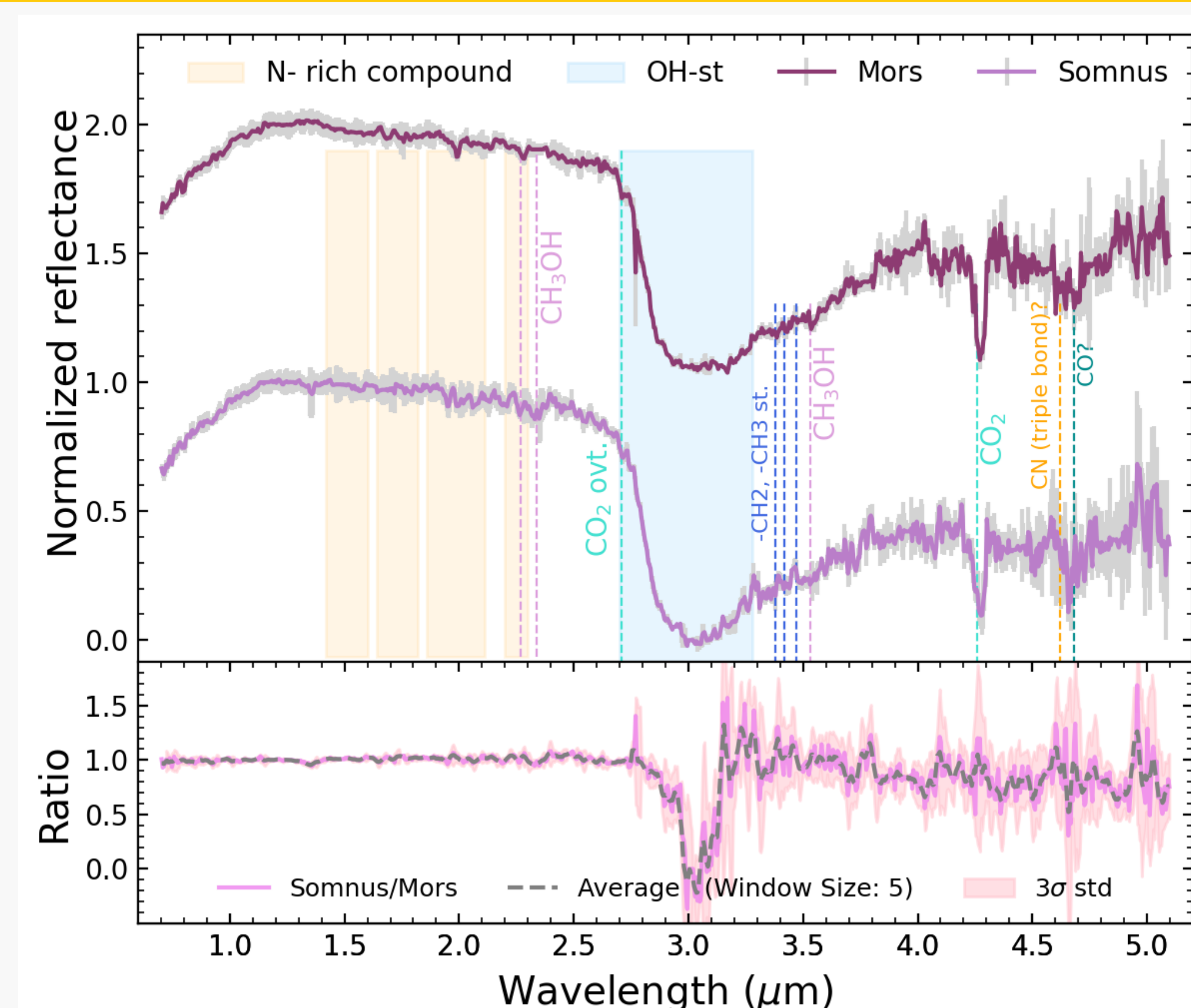


Fig. 2 – Top: Tentative species identifications in the spectra of Mors (dark purple) and Somnus (light purple), normalized at 1.25 μm and the spectrum of Mors was shifted 1.0 units up for clarity. The shaded regions represent where the listed materials can be absorbed. Methanol (CH_3OH) is shown in pink, carbon dioxide (CO_2) and its overtones in light green, carbon monoxide (CO) in teal, OH-stretch in light blue, carbon-nitrogen-rich compounds in orange, and aliphatic complex organic molecules in dark blue. **Bottom:** Ratio between the spectrum of Somnus and Mors (pink line). The average moving ratio is shown as a gray dashed line (window size = 5), and the 3σ standard deviation is shown as a pink shaded region.

COLD CLASSIC X PLUTINOS

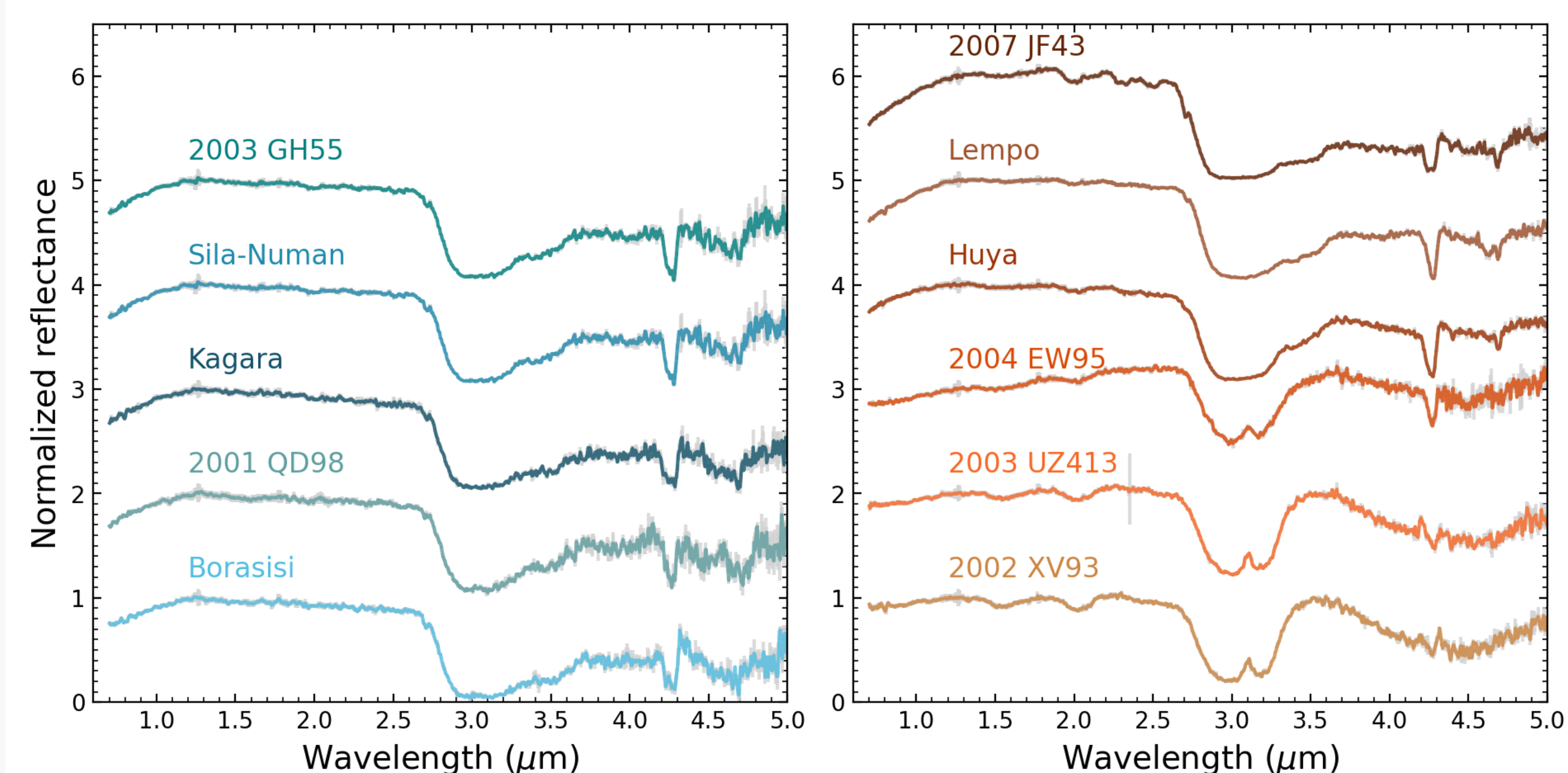


Fig. 3 – Reflectance spectra of cold-classical (left panel, blue shades) and plutino objects (right panel, brown-orange shades) in the DiSCo-TNOs sample. All spectra were normalized at 1.25 μm and vertically shifted for clarity. The light gray bars represent the 1σ errors associated with the normalized spectra.

DISCUSSION AND CONCLUSIONS

- Similarities between Mors and Somnus
 - Implication: Streaming Instability formation scenario (Nesvorný et al., 2010; Nesvorný 2015; Nesvorný & Vokrouhlický 2019)
- Difference in relative reflectance
 - It needs new size/albedo estimations!
- Homogeneity of cold classical TNOs
 - Implication: in-situ formed group in the outer solar system (Parker & Kavelaars 2010).
- Inhomogeneity between the Plutinos (**SEE TALK 11.05 ON THURSDAY!**)
 - Implication: group formed for captured objects from several places of the outer solar system (Nesvorný, 2015).
- Resembling of Mors-Somnus and Cold classical TNOs.
 - Implication: survivor from a $> 30\text{AU}$ captured on the Plutino resonance.

REFERENCES

- | | | |
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| Souza-Feliciano et al., 2024, A&A, 681, L17. | Nesvorný & Vokrouhlický, 2019, Icarus, 331, 49. | Nesvorný et al., 2010, AJ, 140, 785. |
| Sheppard et al., 2012, AJ, 143, 58. | Nesvorný, 2015, AJ, 150, 68. | Parker & Kavelaars, 2010, ApJ, 722, L204. |
| Thirouin et al., 2014, AA, 569, A3. | Hahn & Malhotra, 2005, AJ, 130, 2392. | |