THE PERPLEXING ORIGIN OF (269) JUSTITIA, THE RENDEZVOUS TARGET OF THE EMIRATES MISSION TO EXPLORE THE ASTEROID BELT.

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Motivation. (269) Justitia, the rendezvous target of the *Emirates Mission to Explore the Asteroid Belt*, is a 54 km diameter body with a 0.08 albedo in the central main belt (**Fig. 1**) [1]. This makes it comparable to many C-complex asteroids. Yet, it is also one of the two reddest objects in the inner solar system ─ the other being (203) Pompeja, a ~110 km asteroid with similar characteristics [1]. Both have spectra analogous to very red KBOs, and that could imply a shared origin. If true, Justitia/Pompeja would be the most accessible very red KBOs in the solar system, and prime targets for *in situ* exploration. The problem is that other putative captured KBOs in the main belt, Hilda, and Jupiter Trojan populations lack very red objects (**Fig. 1**) [2]. Why?

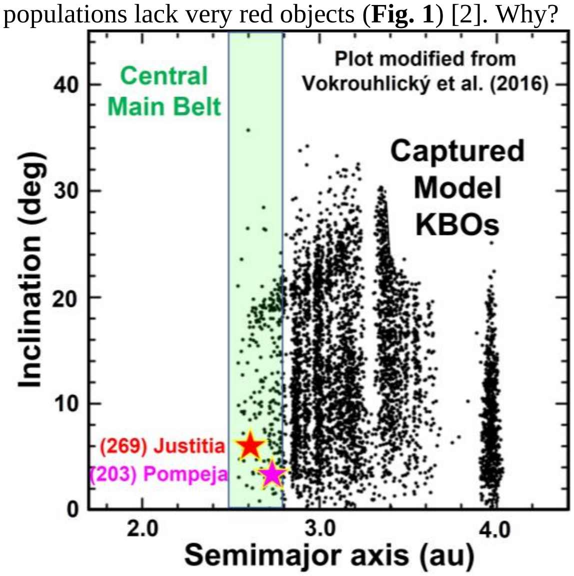

Fig. 1. *Model of captured KBOs between 2-5 au [3].*

Evolution of the Primordial Kuiper Belt. The putative source of Justitia/Pompeja was the primordial Kuiper belt (PKB) that once extended between ~24 and ~50 au [4]. PKB objects likely had a gradient of surface compositions that increased their spectral redness with distance (i.e., related to the sublimation distances of ammonia, methanol, hydrogen sulfide [2]). The transition zone between red and very red objects was probably near or modestly exterior to ~30 au [5,6].

After the solar nebula dissipated, Neptune entered the PKB and migrated across it to 30 au. This triggered a dynamical instability that led to a more eccentric Neptune, the ejection of 99.9% of the PKB onto giant planet-crossing orbits, and encounters between the giant planets [4]. The combination helped capture KBOs in small body reservoirs like the Kuiper belt, scattered disk, Jupiter/Neptune Trojans, Hildas, and D/P-type asteroids in the main belt (e.g., [3,4]).

Curiously, very red objects have only been found in distant populations (i.e., Neptune Trojans, Kuiper belt, scattered disk, and certain Centaurs from the scattered disk [2,5,6]). This makes it a surprise that Justitia and Pompeja reside in the central main belt. Given that KBOs captured in the inner solar system are mixtures of objects originally located between ~24-30 au, our expectations are that very red KBOs should be prevalent in the outer main belt, Hilda, and Jupiter Trojan populations, where numerous D/P-types are found, and relatively few should be in the central main belt (**Fig. 1**) [3,4]. Observations also show that very red Centaurs become less red as they approach the Sun [7]. This makes it hard to understand how Justitia/Pompeja's very red spectra could have survived 4.5 Gyr of collisional evolution, space weathering, and solar heating.

Possible Solutions. Here we suggest two possible ways to explain the unusual origins of Justitia/Pompeja:

(1) Justitia/Pompeja were among the last KBOs captured in the inner solar system. Here we assume that very red objects were ejected out of the PKB near the end of Neptune's migration. Giant planet encounters were largely complete at this time, so main belt capture events may have been limited to the central main belt via interactions between Jupiter and a Neptune-sized ice giant [6]. Justitia/Pompeja may also have had a large enough buffer of organics/water ice in their near surface to preserve their spectral signatures. Smaller very red objects without such reservoirs (e.g., observed Centaurs) may become less red over faster timescales.

(2) Justitia/Pompeja are not KBOs. Instead, they are low albedo bodies from the giant planet zone, like much of the main belt [8]. If true, an unknown process is responsible for their singular spectral signatures.

Key mission goals are to determine Justitia's origin via a combination of images, spectral studies, and thermal inertia measurements.

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References. [1] Hasegawa, S. et al. (2021) *ApJL.* **916**, L6. [2] Jewitt, D. (2018) *Astron. J.* **155**, 56. [3] Vokrouhlický, D., et al. (2016) *Astron. J.* **152**, 39. [4] Nesvorný, D., et al. (2019) Astron. J. **158**, 132. [5] Bolin, B. T., et al. (2023) *MNRAS* **521**, L29. [6] Nesvorný, D., et al. (2020) *Astron. J.* **160**, 46. [7] Jewitt, D. (2015) *Astron. J.* **150**, 201. [8] Walsh, K. J., et al. (2011) *Nature* **475**, 206.