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Spectroscopic Differences Between High-Inclination Primitive Inner Belt Asteroid Families

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Abstract

We present NIR spectra of 11 objects in the Chaldaea family obtained with NASA's InfraRed Telescope Facility (IRTF) and the Telescopio Nazionale Galileo (TNG) between January 2017 and July 2019. From our sample we conclude that Chaldaea objects have red slopes and positive curvature, and are essentially identical to each other within the uncertainties. This is clearly different from the spectra of objects in the Klio family, which show flat featureless spectra with marginally less red slopes. These differences are consistent with the conclusions of Morate [6] that the Klio and Chaldaea families originated from the same parent body and may be explained by more extensive space weathering of Chaldaea asteroids.

1. Introduction

The PRIMitive Asteroid Spectroscopic Survey (PRIMASS) is a visible and near-infrared (NIR) study of primitive (i.e., low albedo) asteroids throughout the asteroid belt. Nesvorny [3] defined 8 primitive families in the inner asteroid belt: Polana-Eulalia, Erigone, Sulamitis, Clarissa, Chaldaea, Klio, Svea, and Chimaera (Fig 1). PRIMASS has already characterized all 8 families in the visible, and Polana and Klio in the NIR ([1],[2],[4],[5],[6],[7]). This work adds to our previous work by characterizing the Chaldaea family in the NIR.

In the visible, the Chaldaea family is spectrally homogeneous and 79% of the objects show evidence of being aqueously altered ([6]). The Chaldaea and Klio families share similar orbital elements (high inclination and eccentricity) and they seem to complement each other compositionally, leading Morate [6] to propose that Klio and Chaldaea objects might have originated in one parent or progenitor body, with Klio objects near the core and the more hydrated Chaldaea objects near the surface.

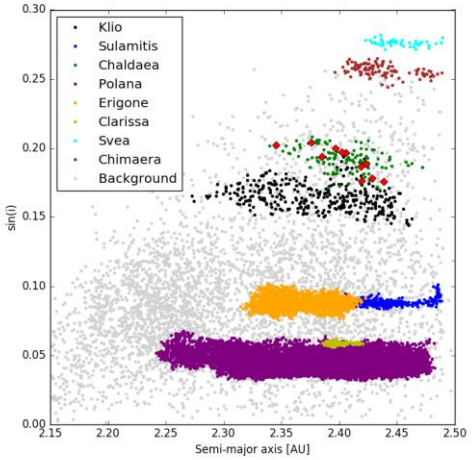

Figure 1: Semimajor axis and inclination of the eight primitive asteroid families in the inner belt defined by Nesvorny [3]. Objects in this study are highlighted with red diamonds.

2. Observations

Near infrared (0.7-2.5 μm) spectra were taken between 2017-2019 using two different sites. We used the SpeX spectrograph in the low-resolution PRISM mode at the 3.0 m NASA Infrared Telescope Facility (IRTF) at Mauna Kea Observatory and the NICS spectrograph at the 3.56 m Telescopio Nazionale Galileo (TNG) at the Roque de Los Muchachos Observatory in Spain. Targets were chosen if they were bright enough (V<18) to achieve an acceptable S/N of ~50 in ~1 hour of observing time in PRISM mode on the IRTF. Priority was given to objects that PRIMASS has already observed in the visible (e.g., [6]). We observed 11 of the 132 total Chaldaea objects, including the largest body, asteroid (313) Chaldaea. An example of the obtained spectra can be seen in Fig 2.

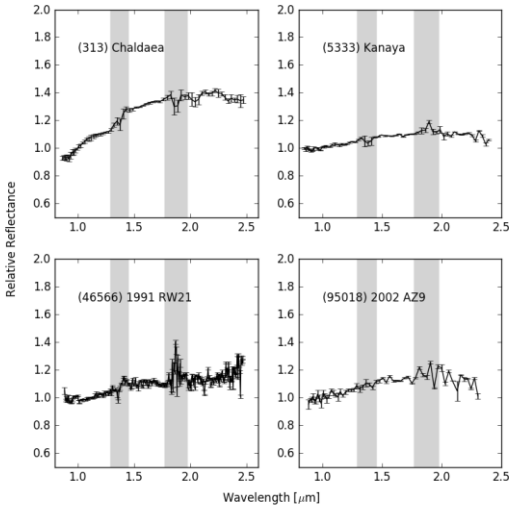

Figure 2: Near-infrared spectra of several Chaldaea asteroids presented in this work. All spectra have been normalized at 1 μm.

3. Summary and Conclusions

The spectral slope, S', of each object was calculated using the method described in Morate [5] in the range from 0.95-2.2 μm. Fig 3 shows the distribution of spectral slopes for the Chaldaea family objects, with a mean slope of 1.31 ± 0.12 %/1000Å. The sample is spectrally homogenous and similar to the range of spectral slopes for the Klio family. The average slope of the Chaldaea family is redder than the average slope of the Klio family (0.99 ± 0.15 %/1000Å). All of the Chaldaea objects in our sample show positive curvature (i.e., concave shapes), while the Klio objects are evenly distributed between concave and convex shapes. These spectral differences support the hypothesis of Morate [6] that the Klio and Chaldaea objects originated from the same parent or progenitor body.

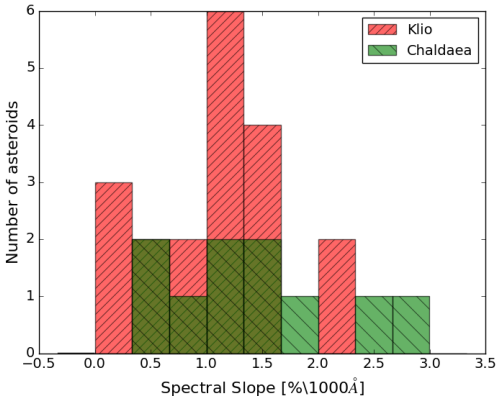

Figure 3: Distribution of spectral slopes of the Klio and Chaldaea families.

Acknowledgements

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