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Limb topography of MU_{69}

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Abstract

On January 1st, 2019 the New Horizons spacecraft made its historic flyby of MU_{69} [1]. MU_{69} is the first cold classical Kuiper Belt object to be visited by a spacecraft. Careful measurements of the limb position allows for accurate topographic profiles that are continuous along large portions of the body. By understanding the shape and topography of MU69, we can begin to characterize the first order processes that have shaped this world.

1. Methods

Four independent methods have been used to determine the limb in the MU69 flyby images. All methods start with an initial estimate for the body center and use sub pixel interpolation to increase precision. These methods find the exact limb as follows

1. Scanning along each row and column of pixels, pick the point at which the brightness is 50% of the face brightness.

2. Scanning radially away from the body center, pick the point at which the brightness is 50% of the face brightness.

3. Because the limb is a sharp change in brightness it is often a peak in the image gradient. Our third approach finds the circle that minimizes the distance between the rim and peak gradient.

4. Scanning radially away from the body center, pick the maximum gradient.

Methods 1-3 were also used to determine the shape of Pluto and Charon. These methods are described in detail in Nimmo et al. [2]. These methods are able to consistently pick the limb with <0.25 pixel accuracy when compared with synthetic images and with each other.

2. Limb Profiles

Limb picks for four stacked close approach images are shown in Figure 1. The low phase angle illumination earlier in the approach sequence allow for accurate limb picks around nearly the entire object. Picks done on by methods 1 and 2 agree to within $\sim 1/10$ of a pixel.

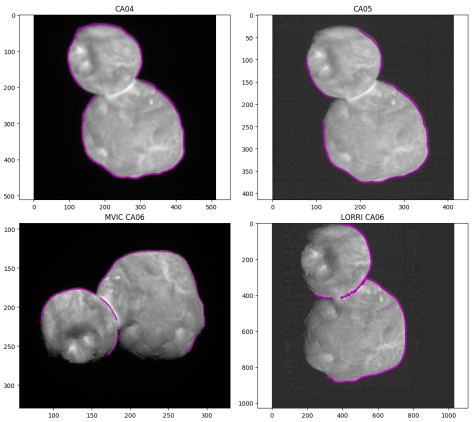

Figure 1: Four stacked images from the MU_{69} flyby with the limb picks in magenta. In the closest approach images (CA06) we have also used the image gradient to pick the neck region.

Figure 2 shows the limb picks for the two lobes with a best fit circle removed. While a circle is not a good representation of the long-wavelength shape of MU_{69} is allows for a first pass at understanding the topography. In this view the large lobe shows topographic

variations of ± 1 km, about twice that of the smaller lobe. It is also clear in these profiles that as the spacecraft approached MU_{69} distinct topographic features came into view.

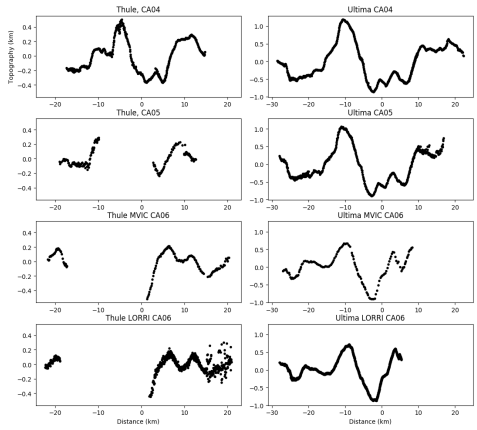

Figure 2: Limb profiles using method 1 with a best fit circle removed from each. The left panels are for the small lobe (unofficially named "Thule") and the large lobe is on the right (unofficially named "Ultima") While some long wavelength structure remains there is clear topography on both lobes.

Topographic roughness measurements are being performed on these limb profiles [3]. Initial work has found that these measures are sensitive to the long wavelength shape removed from the profiles. Because of this it is important to not just remove a best fit circle or ellipse (as is done for Figure 2) but calculate the potential height given the irregular shape of this world [4, 5].

3. Summary and Future work

Limb profiles are being produced for the close approach images of MU_{69}. This profiles are providing valuable information about the shape and topographic relief of this world. Detailed analysis using the irregular gravity field to determine true slopes and their implications is ongoing.

References

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