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Latitude Zones and Seasons on 2014 MU 69 'Ultima Thule'

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Abstract

On January 1, 2019 NASA's New Horizons spacecraft flew close to the Kuiper Belt Object (486958) 2014 MU69 nicknamed "Ultima Thule" (herein MU69). MU69 is a bi-lobed contact binary with a flattened shape, and discrete geological units and albedo heterogeneity, including a bright "collar" around the neck region connecting the two lobes [1]. MU69 has a high obliquity of around 99° with respect to its heliocentric orbital plane, a rotation period of 15.94 hours and an orbital period of 293 years. MU69's high obliquity and non-spherical shape give rise to a unique set of latitudinal zones and seasonal cycles on MU69.

1. Overview

MU69 orbit indicates it is a member of the Cold Classical Kuiper Belt population because of its low dynamical excitation. This class of objects are thought to be more or less dynamically undisturbed bodies that formed in situ ~4.5 Gyr ago and have since remained at or close to their current, large heliocentric distances [2,3]. Evidence suggests MU69's spin period and obliquity are unlikely to have substantially changed since the binary merger [1].

Here we explore the unique latitudinal zones and seasonal cycles on MU69 created by its high obliquity (99°) and non-spherical shape (Figure 1). We evaluate ray tracing for incoming solar insolation and consider thermal re-radiation from surrounding regions. We also consider the limits of MU69's "climate zones" (as defined by [4]). As a result of its high obliquity, most of MU69's surface is in the "Tropical Arctic" region. "Tropical Arctic" is defined as regions where the Sun reaches the zenith and at some point during the orbit the Sun does not set or rise for one complete rotation or more.

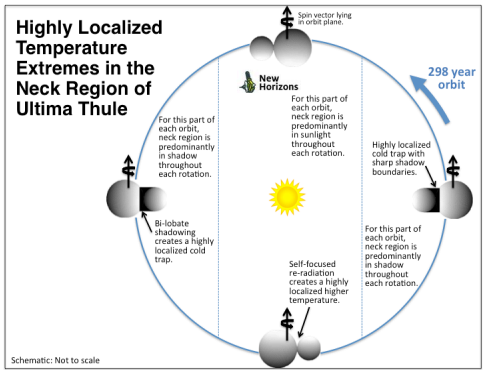

Figure 1: Reproduced from [5] Binzel et al. *LPSC* 2019. Highly localized seasonal variation in the Neck Region of MU69 "Ultim Thule".

Additionally we consider implications for the formation of the less-dark, less-red narrow "collar" feature in the neck region of the bi-lobate body [1]. [5] first hypothesized that this distinct feature may be created and maintained by highly-localized seasonal

shadowing effects created by MU69's bi-lobate shape and nearly in-plane spin vector orientation. They suggest that since shadows on airless bodies create sharp boundaries, shadowing effects may play a role in creating sharply delineated features such as the "collar". Additionally, during the portions of MU69's orbit where the neck region does receive sunlight, re-radiation in this area may drive temperatures higher than what is expected on the lobes. This talk will present work that is currently underway to quantitatively determine whether the extreme variations in net radiation in the neck region of MU69 might promote seasonal or occasional trapping and release of volatiles in a sharply delineated region consistent with the morphology of the "collar" feature. Thermophysical analysis is also underway to explain the brightness temperature observed by the REX instrument and will be presented in [6].

2. Summary and Conclusions

MU69's high obliquity and bi-lobate shape create unique seasonal cycles and latitudinal zones. Here we evaluate ray tracing for incoming solar insolation, consider re-radiation from surrounding regions, and the boundaries of MU69's "climate zones". We also consider whether or not these factors could drive the formation of and maintain the bright "collar" feature around he neck between the lobes.

3. Acknowledgements

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References

[1] Stern, S.A. et al.: Initial results from the New Horizons explorations of 2014 MU69, a small Kuiper Belt Object, Science, vol.364, 2019.

[2] Tsiganis, K. et al.: Origin of the orbital architecture of the giant planets of the Solar System, Nature, 2005.

[3] Nesvorný, D.: Dynamical evolution of the early Solar System, Annual Reviews Astronomy and Astrophysics, vol. 56, pp.137-174, 2018.

[4] Binzel et al.: Climate zones on Pluto and Charon, Icarus, vol. 287, pp. 30-36, 2018

[5] Binzel, R.P. et al.: Highly Localized Seasonal Cold-Trapping in the Neck of 2014 MU69 'Ultima Thule', Lunar and Planetary Science Conference, 2019.

[6] Umurhan, O. et al.: Near Surface Temperature Modeling of 2014 MU69, DPS/EPSC Abstract (this meeting), 2019.