IS THE LONGITUDINAL DISTRIBUTION OF WATER ICE DIFFERENT ON MIRANDA COMPARED TO THE OTHER URANIAN SATELLITES?

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Introduction: Various processes modify the surfaces of icy satellites orbiting giant planets, including excavation and overturn of their regoliths by impacts, interactions with the host planet's magnetosphere, and mantling by circumplanetary dust populations. In the Uranian system, the strength of these processes is expected to vary with distance from Uranus and with longitude on the satellite, possibly explaining the observed asymmetries in the strength of H_2O ice absorption bands between the leading (apex) and trailing (antapex) hemispheres of its four largest "classical" moons Ariel, Umbriel, Titania, and Oberon [1,2]. In contrast, Miranda, the smallest and innermost classical moon, does not appear to display a leading/trailing asymmetry in the strength of its near-infrared (NIR) H_2O ice bands [3,4]. This raises the question: what processes are controlling the spatial distribution of surface constituents on Miranda?

Observations: To further investigate Miranda's surface composition, we carried out an observing campaign in 2019-2020 to collect near-infrared spectra of Miranda's surface with the ARC 3.5m telescope and the TripleSpec instrument. This campaign achieved comprehensive longitudinal coverage of Miranda's northern hemisphere, collecting a total of 20 new NIR spectra, supplemented by two new NIR spectra acquired with the GNIRS instrument on the Gemini North 8.1m telescope. Combined with previously-published observations with the SpeX instrument on NASA's 3m IRTF telescope, this effort has brought the longitudinal coverage of NIR spectra of Miranda up to par with that of the other classical Uranian satellites. We categorize our spectra in four 'quadrants' of longitude on Miranda's surface: the leading quadrant (46–135°), the anti-Uranus quadrant (136–225°), the trailing quadrant (226–315°), and the sub-Uranus quadrant (316–45°). In some of our analyses, we instead categorize our spectra into the leading hemisphere (1–180°) and the trailing hemisphere (181–360°).

Analysis: We measured the integrated band areas and fractional band depths of the 1.52-μm and 2.02-μm H_2O ice absorption bands in each of our acquired spectra in order to constrain longitudinal variation in the strength of these absorption features. We applied statistical tests to ascertain whether the variation in band area/depth with longitude was consistent with a sinusoidal model or a constant mean. We also calculated mean ratios of band strength between opposing quadrants and hemispheres of Miranda's surface.

Results: The results of our analyses indicate that the ratio of integrated H_2O ice absorption band areas and depths between the leading and trailing hemispheres of Miranda is significantly lower than that on the other Uranian satellites, suggesting minimal asymmetries in H_2O ice abundance between these two hemispheres. The same pattern holds if only the leading and trailing quadrants are considered. When taken in the context of the processes and compositional trends found in the Uranian system, this is an intriguing result. However, with our comprehensive longitudinal coverage, we instead found a statistically significant asymmetry in H_2O ice band areas and depths between the anti-Uranus and sub-Uranus quadrants of Miranda's surface, but only for the 1.52-μm band. We do not detect any statistically significant variation in the 2.02-μm band areas or depths with longitude. We will present the results of our observing campaign, focusing on the longitudinal distribution of H_2O ice on Miranda and potential explanations and implications for our findings in the context of Miranda and the larger Uranian system.

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References: [1] Grundy et al. (2006) *Icarus*, 184, 583. [2] Cartwright et al. (2015) *Icarus*, 257, 428. [3] Gourgeot et al. (2014) *A&A*, 562, A46. [4] Cartwright et al. (2018) *Icarus*, 314, 210.