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New Horizons REX Radiometry at 2014 MU69

I. R. Linscott (1), M. K. Bird (2,3), G. L. Tyler (3), M. Pätzold (2), S. A. Stern (4), H. A. Weaver (5), L. A. Young (4), C. B. Olkin (4), J. M. Moore (6), W. M. Grundy (7), C. C. DeBoy (5), Sepan, R (5)., M. A. Vincent (4), A. Bowman (5), K, Oudrhiri (8)
(1) Department of Electrical Engineering (ret) (linscott@stanford.edu), Stanford University, Stanford, CA 94305, (2) Rheinisches Institut für Umweltforschung, Universität Köln, 50931 Cologne, Germany, (3) Argelander Institut für Astronomie, Universität Bonn, 53121 Bonn, Germany, (4) Southwest Research Institute, Boulder, CO 80302, (5) The Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723, (6) NASA Ames Research Center, Moffett Field CA 94035, (7) Lowell Observatory, Flagstaff AZ 86001, JPL, Pasadena, CA, 91109.

Abstract

During the encounter with the KBO 2014 MU69 (referred to informally as Ultima Thule in the following), the New Horizons Radio Science Experiment (REX), measured radio thermal emission at the wavelength of 4.2 cm. Two radiometry observations were conducted, one on approach, and one on departure. Brightness temperature measurements were made of the unresolved disk. An additional bistatic radar experiment was performed during the departure thermal scan. We present the observations and provide preliminary interpretations of the measured brightness temperatures and bistatic experiment.

1. Introduction

On 1 January 1 2019, the New Horizons spacecraft approached to a minimum distance of 3,539 km from Ultima Thule, a small (35 x 20 x 10 km) KBO, believed to be among the most primitive objects in the solar system [4]. Cameras on-board New Horizons photographed a slowly rotating bi-lobate contact binary whose rotation pole points almost directly to the Sun. Spectroscopic images showed that Ultima Thule has a very low surface albedo, is dark red in color, and is unusually smooth. Thermal emission measurements of the nightside by the REX instrument [5] indicate that the brightness temperatures are very cold, as expected of a surface unilluminated by the sun and exposed to interstellar space for a very long time. Data from the encounter are still being retrieved from the spacecraft, but the entire REX data set is on the ground.

2. REX Radiometry Observations

REX measurements of radio flux density were recorded with two independent receivers [5]: REX A (right circularly polarization – RCP) and REX B (left circularly polarization – LCP) at a rate of 10 samples per second. The REX radiometry measurements were converted to radio brightness temperature using calibration data obtained earlier in the New Horizons Mission [1,2,3].

2.1 Nightside Thermal Scan

On departure from Ultima Thule the spacecraft's high gain antenna (HGA), was scanned along the nominal error ellipse. Figure 1 illustrates the angular separation between the HGA pointing direction and

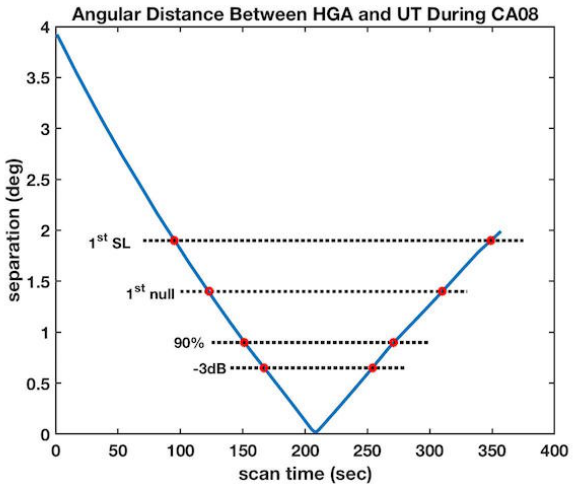

Figure 1: Angular separation between the HGA boresight (nominal pointing direction) and Ultima Thule during the nightside thermal scan.

the position of the KBO during the scan. The HGA intercepted Ultima Thule close to the scan midpoint, differing from the expected intercept by only a few seconds. The thermal scan of Ultima Thule was measured against a background, shown in Figure 2, where the nightside scan direction was close to the galactic plane in the opposite direction from the

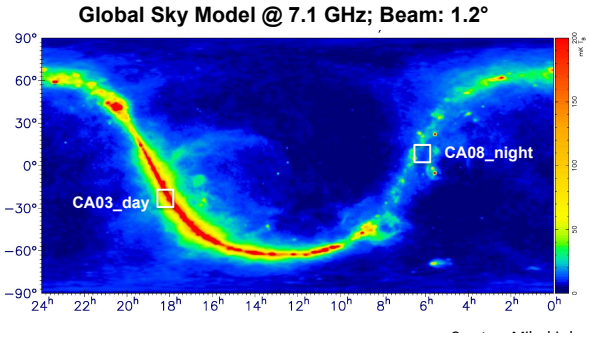

Figure 2: The radio sky at 4.2 cm. All sky map at a resolution corresponding to the HGA beamwidth (1.2°). The CMB temperature 2.73 K has been subtracted.

galactic center.

2.2 Dayside Observation

The dayside radio flux measurement was attempted on approach from a distance of 55,000 km, where the cross-track motion was much less than the angular HGA beamwidth. The dayside observation was thus a *stare* with a resultant signal comparable to the receiver noise level, a disadvantage exacerbated by the close proximity of the dayside stare's direction to the intense portion of the galactic plane, shown in Figure 2.

2.3 Bistatic Experiment

The nightside scan occurred when Ultima Thule displayed a thin crescent of the sun-illuminated limb where a specular point could exist, i.e., a place on Ultima Thule where the Earth would be seen in reflection. Anticipating the existence of a reflection, six powerful signals were transmitted earlier by the DSN from stations at Goldstone, CA, and Canberra, AU. These signals were timed to arrive at Ultima Thule during the nightside thermal scan, where they would scatter from the KBO's surface into the spacecraft's direction and be acquired by REX.

3. Summary

The thermal radio emission at 4.2 cm from the KBO 2014 MU69, aka Ultima Thule, was measured by radiometry observations as part of the REX investigation on New Horizons during the encounter on 1 January 2019. The radio brightness temperatures determined from these observations (≈ 20 K) are consistent with a cold object whose nightside has been thermally isolated from its sun-illuminated dayside for a very long time.

References

[1] Bird, M. K., et al. (2019) *Icarus 322*, 192–209.

[2] Linscott, I. R., et al. (2017) Stanford Radioscience Report No. 17-06-0.

[3] Linscott, I. R., (2019) *Icarus* (submitted).

[4] Stern, S. A., et al. (2019) *Science (accepted)*.

[5] Tyler, G. L., et al. (2008) *Space Sci. Rev., 140*, 217–259.