THE SOLAR WIND, PICKUP ION, ENERGETIC PARTICLE, COSMIC RAY, AND DUST SPACE ENVIRONMENT AT 2014 MU69 (ULTIMA THULE). H. A. Elliott[1], D. J. McComas[2], R. L. McNutt Jr.[3], M. Horanyi[4], G. R. Gladstone[1], F. Bagenal[4]. M. E. Hill[3], P. Kollmann[3], E. Bernardoni[4], M. Piquette[4], L. A. Young[5], E. Zirnstein[2], J. W. Parker[5], S. A. Stern[5], H. A. Weaver[3], J. R. Spencer[5], C. B. Olkin[5], A. Verbiscer[6], [1]Southwest Research Institute, San Antonio TX (helliott@swri.edu), [2]Department of Astrophysical Sciences, Princeton University, Princeton, NJ, [3]Johns Hopkins University Applied Physics Laboratory, Laurel, MD, [4]University of Colorado, Boulder CO, [5]Southwest Research Institute, Boulder, CO, [6]University of Virginia, Charlottesville, VA

Introduction: The New Horizons (NH) mission has collected a rich dataset of solar wind, pickup ion, energetic particle, and dust observations along its trajectory throughout the heliosphere and during flybys through the Jupiter and Pluto systems. On January 1, 2019 New Horizons (NH) flew past the 2014 MU_{69} Kuiper Belt Object (KBO) also known as Ultima Thule. Here, we present the latest NH particle results needed to address the flyby and extended mission objectives to: 1) Characterize the composition and magnitude of any volatile or dust escape from MU_{69}, and 2) Characterize the solar wind, interstellar pickup ions, energetic particles, cosmic ray, and dust environment near MU_{69} (42-46 AU) and across the entire Kuiper Belt (35-50 AU) [1,2,3]. These particle observations provide support for the space weathering analysis and interpretation of the color images since the surface of MU_{69} has been exposed to the solar wind, dust, and energetic particle environment of the outer heliosphere since the early formation of the solar system [1,2,3].

Observations: NH measures the solar wind, pickup ions, energetic particle, cosmic ray, and dust environment using the Solar Wind Around Pluto (SWAP) instrument [4], the Pluto Energetic Particle Spectrometer Science Investigation (PEPSSI) [5], and the Student Dust Counter (SDC) [6]. The SWAP instrument measures ions with energies ranging from ∼21–7800 eV providing excellent coverage of the solar wind proton [7], alpha particle [8], interstellar pickup protons [9], and low energy pickup ions escaping from a planetary body [10], and provides limited coverage of helium interstellar pickup and suprathermal ion tails [9,11]. In interplanetary space the PEPSSI instrument [5] measures ions above a few keV/nuc, up to ~1 MeV (with compositional information above ~30 keV), and Galactic Cosmic Rays above ~100 MeV. The Student Dust Counter (SDC) is an in-situ dust detector that measures the distribution of interplanetary dust particles in the mass range of 10^{-9} to 10^{-12} g or approximately radii from 0.5 to 5 μm [6].

Summary: We provide an overall assessment of the solar wind, pickup ion, energetic particle, cosmic ray, and dust conditions near and at MU_{69}, and remark on any significant radial trends occurring in the outer heliosphere.

The closest approach solar wind, energetic particle, GCR, and dust observations have already been downlinked. Initial results indicate only particle populations consistent with NH remaining in the solar wind were detected, and we found no indications of observing any material from MU_{69}. The SWAP instrument shows the presence of only light ions consistent with H+ interstellar pickup ions, and both solar wind H+ and He++ ions (Figure 1). No heavy ions like those observed in Pluto's tail were found with SWAP[9]. The PEPSSI energetic particle measurements reveal only He+ interstellar pickup ions, solar energetic particles, suprathermal tails, and cosmic rays, which is also consistent with NH remaining in the solar wind. As performed at Pluto, the SDC thresholds were set higher than usual to minimize noise events due to frequent firings of the spacecraft thrusters [12]. During this flyby, the SDC data are consistent with no hits of particles with radii > 1.5 μm in radius. In the limited amount of UV spectrometer observations currently received, no signature of an MU_{69} atmosphere has been found [13]. With no atmosphere, the dust, solar wind, energetic particles and cosmic rays all can impact and change the surface through such processes as ion implantation or sputtering at low energies, or breaking of molecular bonds or excavation at high energies. Final analysis of all the particle observations awaits the downlink of the complete encounter dataset, including additional particle observations, and both the spacecraft attitude and thruster firing information.

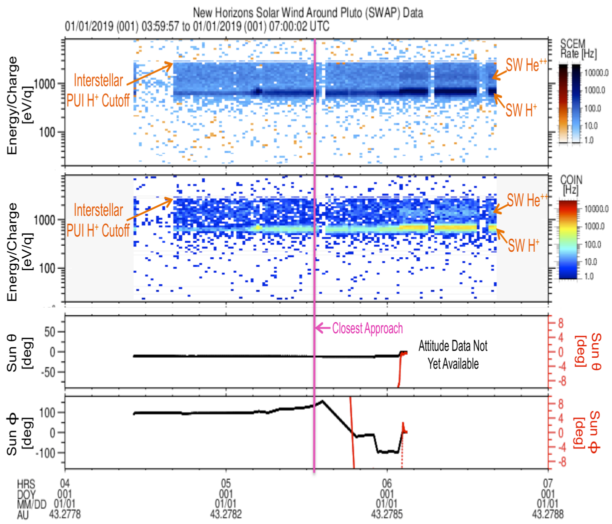

Figure 1: SWAP only observed light ions and clearly observed distinct cold H+ and He++ solar wind beams and a broad H+ interstellar pickup ion distribution. The top panel is an energy per charge versus time count rate spectrogram for the SWAP secondary channel electron multiplier (SCEM) detector where a red (blue) color bar is used for heavy (light ions). When the ratio of the SCEM rate to the PCEM rate is greater (less) than 3 heavy (light) ions are present. The 2nd panel is an energy per charge versus time coincidence count rate spectrogram. The bottom 2 panels show where the Sun is in the SWAP field of view. The θ angle is an instrument latitude, and the ϕ angle is an instrument longitude angle. The black scale covers the full range of angles and the red scale zooms in on the center of the SWAP FOV. Towards the end of the plot the Sun is rotating into the SWAP FOV.

References: [1] Stern et al. (2019) LPSC abstract, [12] Stern et al., (2018), SSR, 77, 23. [3] Moore et al. (2018), GRL, 45, 8111-8120. [4] McComas et al., (2008), SSR, 140, 261-313. [5] McNutt et al., (2008), SSR, 140, 315-385. [6] Horanyi et al., (2008), SSR, 140, 387-402.[7] Elliott et al., (2016) ApJS, 223(2), 19. [8] Elliott et al., (2018), ApJ, 866(2), 85. [9] McComas et al., (2017), ApJS, 233(1). [10] McComas et al. (2016), JGR, 121, [11] Kollmann et al. (2019) submitted to ApJ , [12] Bagenal et al. (2015), Science 351,1282. [13] Gladstone et al., (2019) LPSC abstract.