CONSTRAINING PLUTO'S H AND CH_4 PROFILES WITH ALICE LYMAN-ALPHA OBSERVATIONS.

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Introduction: The Alice instrument on New Horizons performed several observations of Pluto's far-ultraviolet (FUV) airglow emissions during the 2015 flyby. While Pluto's atmosphere is dominated by N_2, the brightest airglow feature at Pluto is due to Lyman-alpha (Lyα) emission of atomic hydrogen. This is because H atoms, produced at lower altitudes during photolysis of CH_4, are able to resonantly scatter the very bright Lyα lines from both the Sun and the interplanetary medium (IPM). While the IPM Lyα flux at Earth is much less than direct solar Lyα, the IPM Lyα brightness falls off much more slowly with distance from the Sun than $1/r^2$**,** so that at Pluto the two sources are of comparable strength [1,2].

Although the Alice instrument has poor spatial resolution, at about 40 minutes prior to closest approach a short "ride-along" scan of Pluto during an MVIC color observation, obtained the highest resolution airglow data of the flyby. For this observation, 11:08:27-11:12:11 UTC on 14 July 2015, the range to Pluto when the Alice slit was centered on Pluto (at 11:11:09 UTC) was 33,750 km, and the Alice 0.3° pixel size was ~175 km (~0.15 R_P), as seen in Fig. 1a.

Resonant Scattering of Lyα at Pluto: At 32.9 AU from the Sun, Pluto was distant enough that the solar Lyα line was considerably extincted due to scattering by H atoms in the interplanetary medium. Since Pluto was close to upstream in the interstellar wind, however, this extinction was shifted from line center by about 20 km/s (~18 Doppler widths from line center for 70-K H atoms in Pluto's upper atmosphere) and thus has very little affect. Using predicted H and CH_4 densities from a recent model of Pluto's photochemistry appropriate for the New Horizons flyby [3], we find that the brightness of Lyα due to resonantly scattered sunlight is ~30 Rayleighs (R), and that, behind this, Pluto's methane absorbs the brighter (~70 R) IPM Lyα background to an altitude of ~450 km (Fig. 1b). The actual P_Color2 observation matches the prediction quite well (Fig. 1c).

In this talk we will further discuss how Lyα emissions are formed at Pluto, and will show curve-of-growth predictions for Pluto's Lyα corona as seen from New Horizons to constrain both the H and CH_4 densities for use in photochemical models.

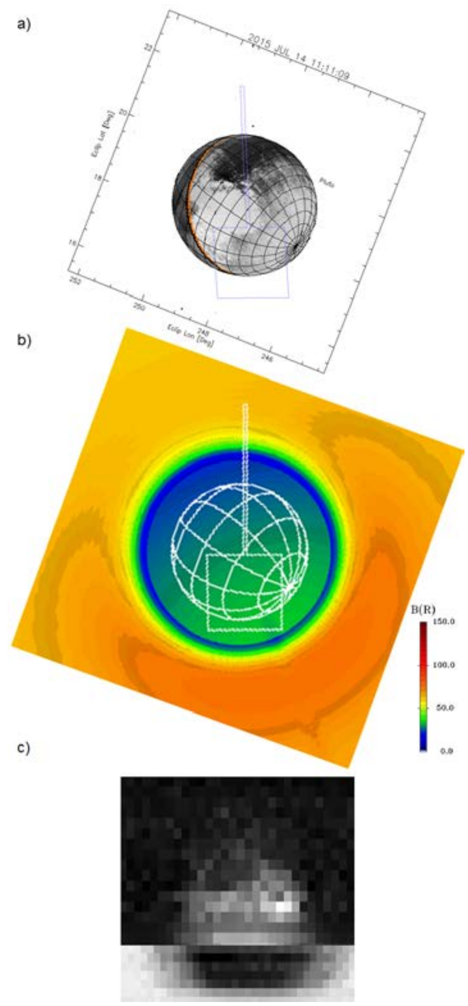

Fig. 1. a) New Horizons view during the P_Color2 Pluto scan, when the Alice slit was centered on the disk (11:11:09 UTC on 14 July 2015). b) Simulated Lyα signal from Pluto (~30 R) and IPM background (~70 R, absorbed by Pluto's methane at z<450 km). c) P_Color2 Alice data, integrated over 4s, with reflected FUV light in the "slot" (the narrow 0.1°×4° part of the Alice slit), and Lyα emissions in the "box" (the wide 2°×2° part of the Alice slit), showing the expected methane absorption of the background IPM emissions.

References:

[1] Gladstone G. R. et al. (2015) *Icarus*, *246*, 279-284. [2] Steffl A. J. et al. (2019) *Icarus*, in press. [3] Wong M. L. et al (2017) *Icarus, 287*, 110-115.