Neon Abundance in the Lunar Exosphere from LACE Data

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Description of the Project

- Apollo 17 carried a mass spectrometer, called the

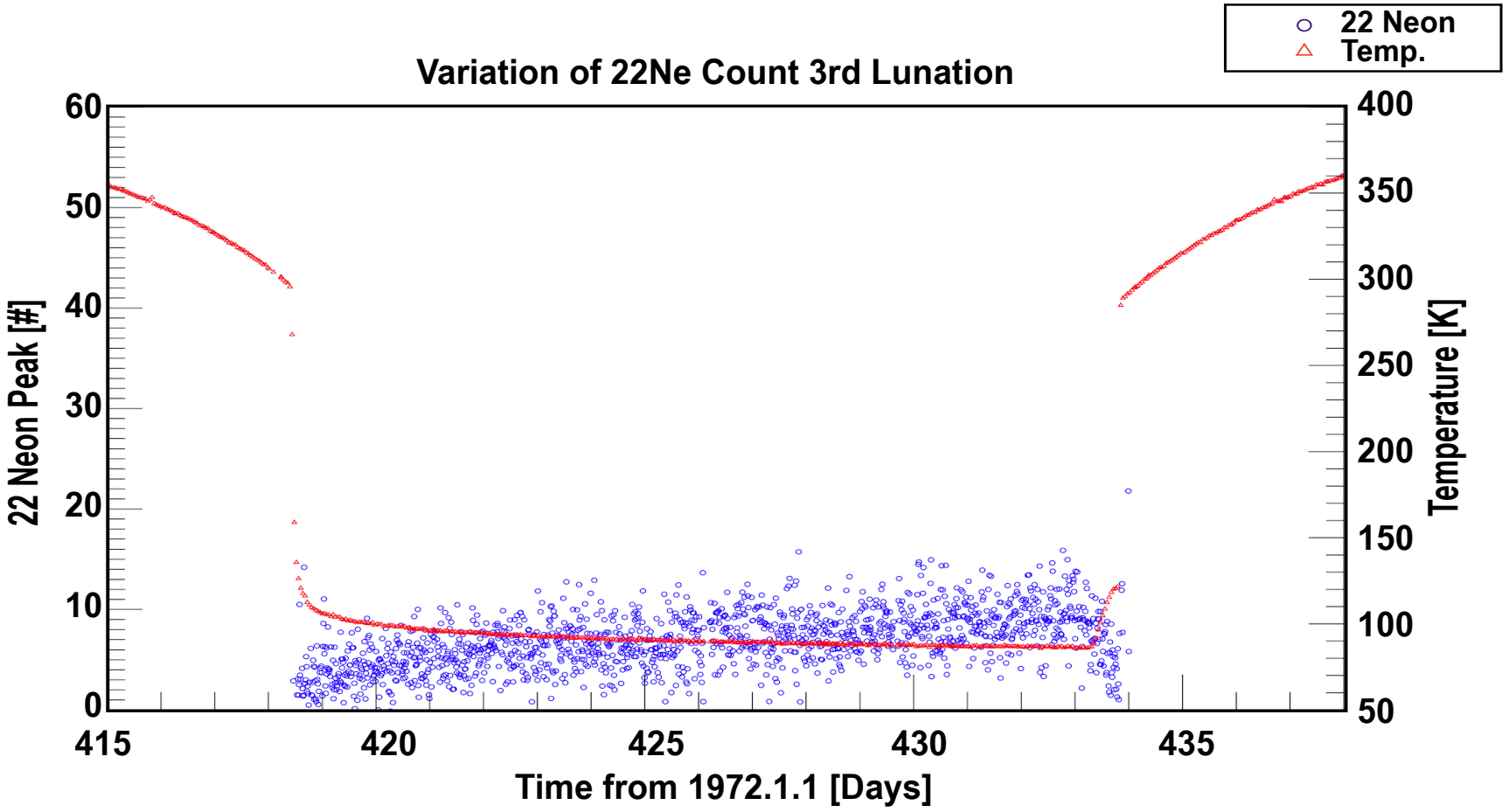
Lunar Atmospheric Composition Experiment (LACE),

- part of the Apollo Lunar Surface Experiments Package (ALSEP)
- deployed in the Taurus-Littrow Valley
- turned on December 27, 1971
- We reanalyzed these data to determine the Ne density and its variation

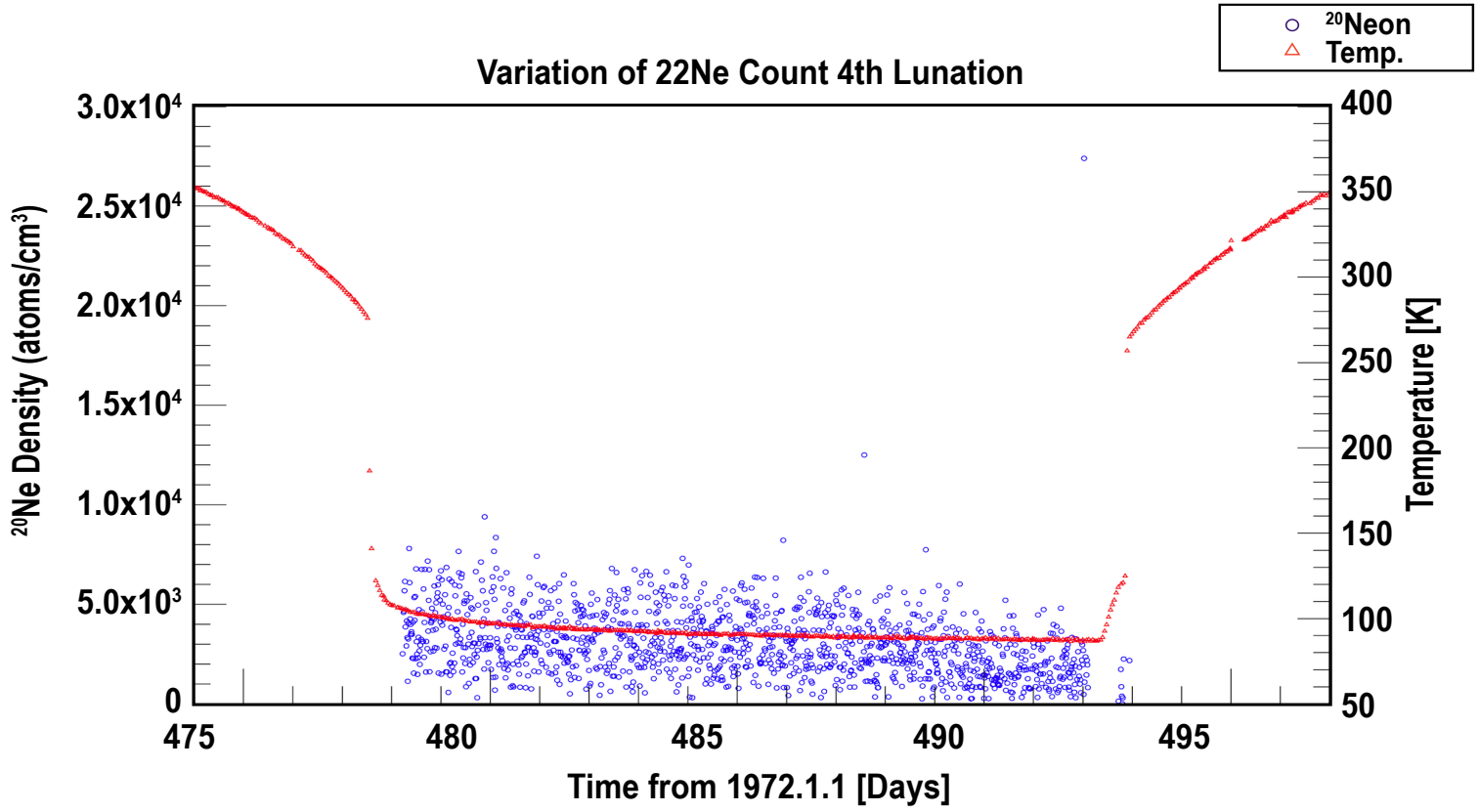
Highlights

- LACE data from Apollo 17 have been reanalyzed
- The ^{20}Ne nightside surface number densities are 3 ($\pm$1.5) x10^{3} cm^{-3}
- Our derived Ne abundance cannot be modeled assuming dynamic equilibrium with the solar wind and a photoionization lifetime of 100 days

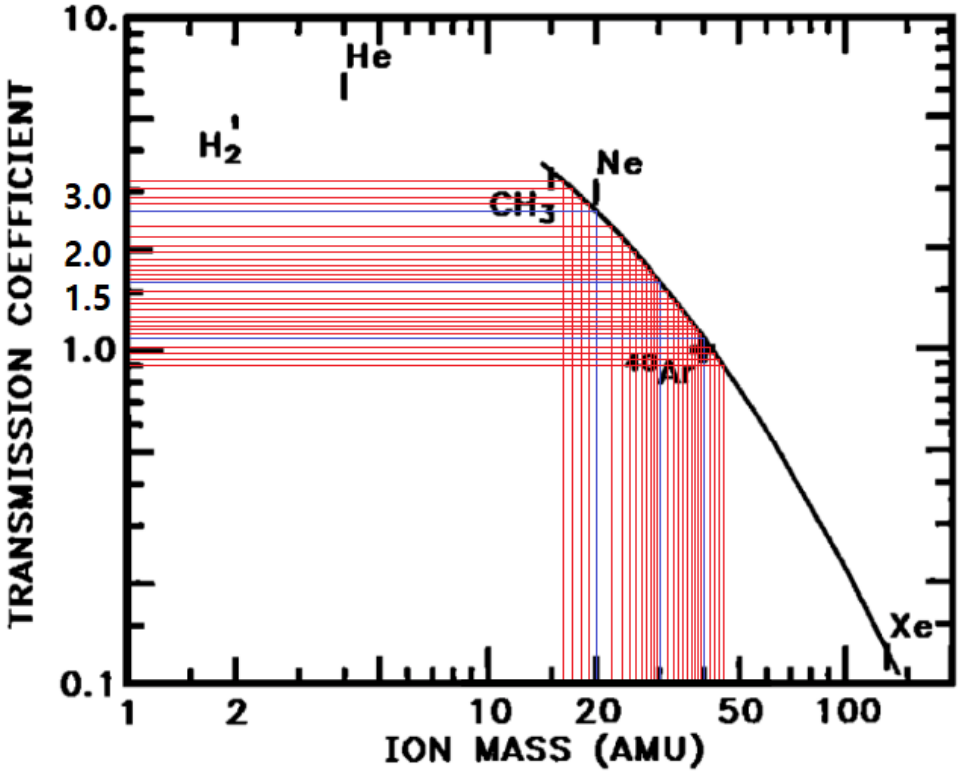
VARIATION OF Ne SEEN ON 3RD LUNATION



LACE Data for Neon: 4th lunation



CALIBRATION OF THE DATA



Calibration was performed on an identical Spectrograph that flew on a Venus mission

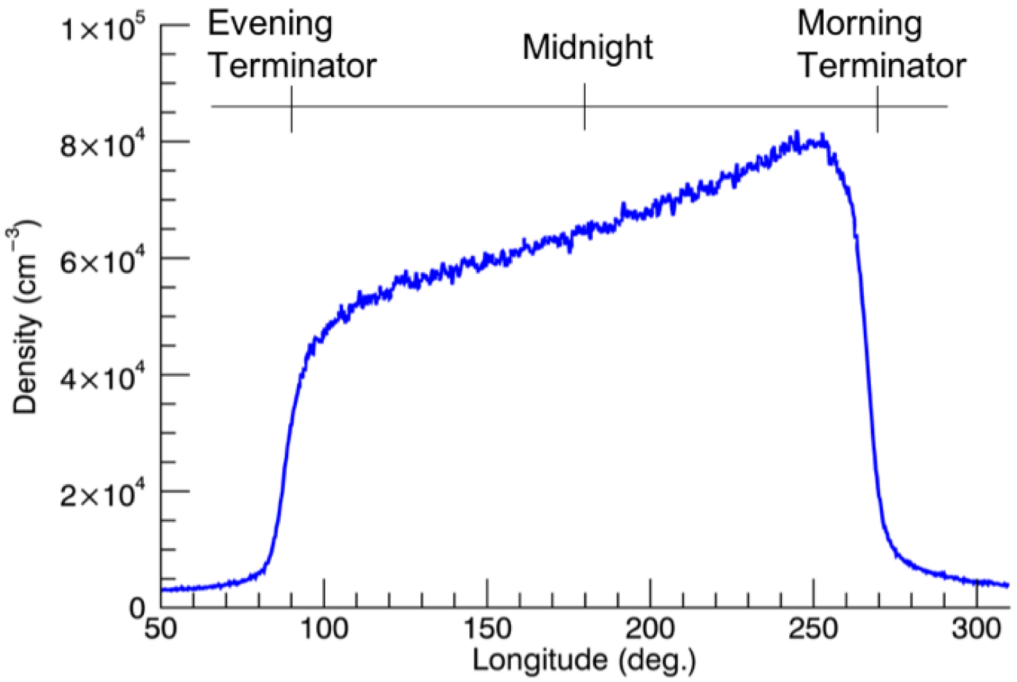
WE USED M/Q=22 TO INFER ^{20}Ne

- M/Q=20 contains ^{20}Ne, HF, and Ar^{++}
- M/Q=22 is assumed to be uncontaminated
- ^{22}Ne is 9.25% of all Neon

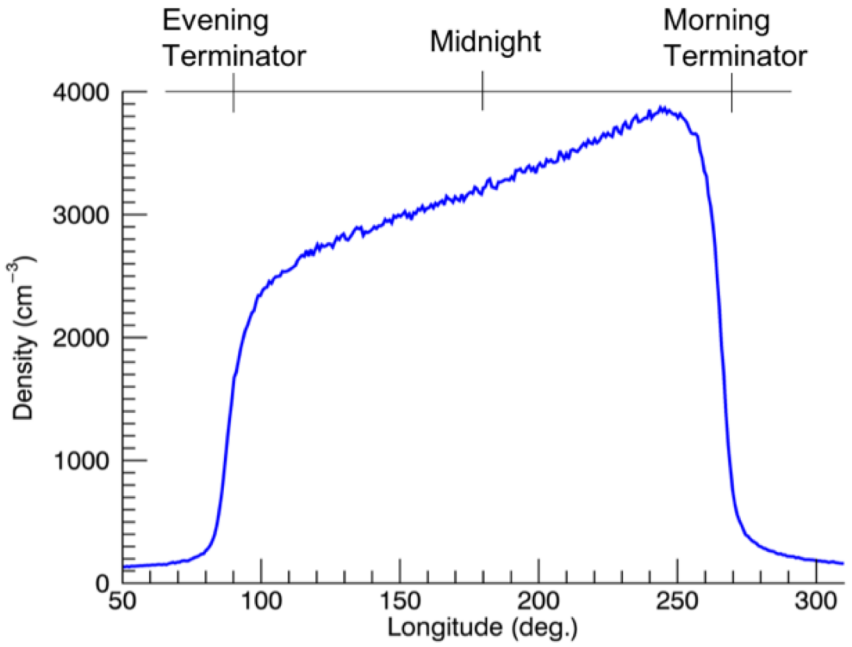
Table. ^{20}Ne densities estimated for lunations 2 - 5

Lunation	Dates	^{20}Ne Density
2nd	Jan. 24 - Feb. 8, 1973	$(1.5 - 3.5) \times 10^3$ atoms$/cm^3$
3rd	Feb. 22 - Mar. 9, 1973	$(2.0 - 4.5) \times 10^3$ atoms$/cm^3$
4th	Mar. 24 - Apr. 8, 1973	$(2.0 - 4.0) \times 10^3$ atoms$/cm^3$
5th	Apr. 23 - May 7. 1973	$(2.0 - 4.0) \times 10^3$ atoms$/cm^3$

SIMULATIONS



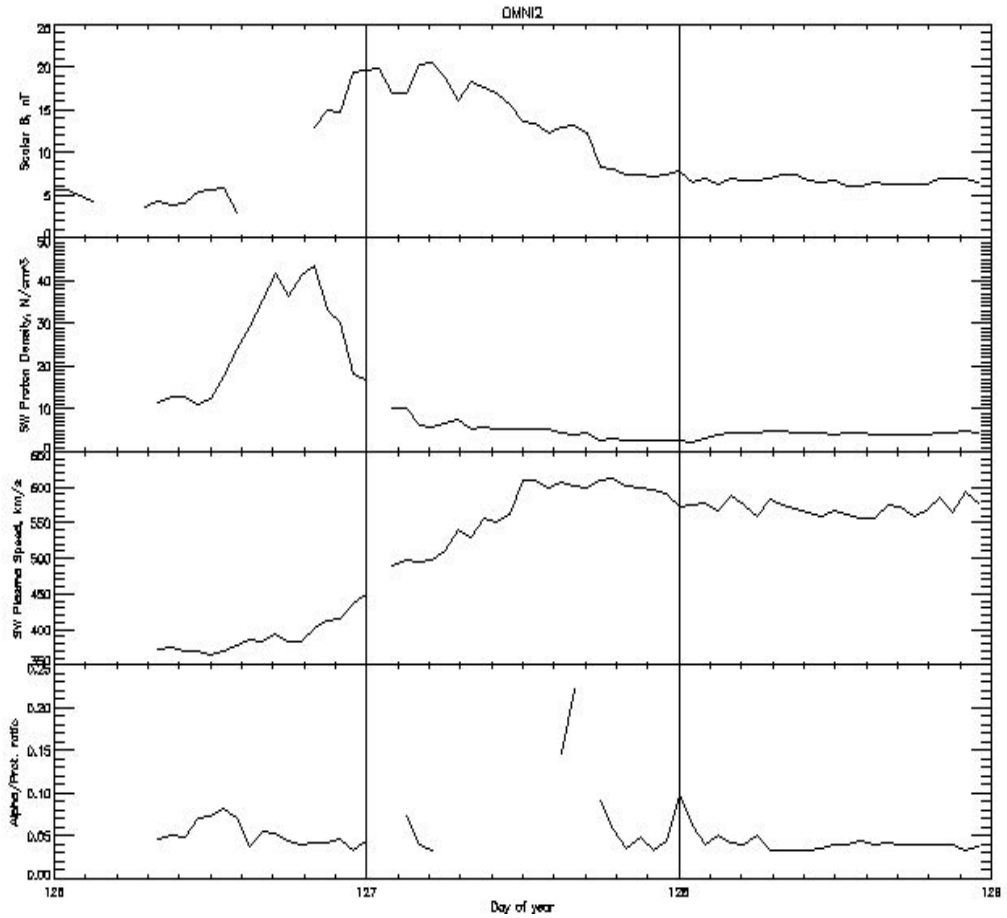
LIFETIME = 100 DAYS



LIFETIME = 4.5 DAYS

Simulations (1, 2) of neon density at TL using nominal SW flux $N_{SW}v_{SW}(Ne) = 1.65 \times 10^4$ cm^{-2}s^{-1} and the photoionization lifetime of 100 days (a) and 4.5 days (b).

SOLAR WIND DATA DOY 126 - 128

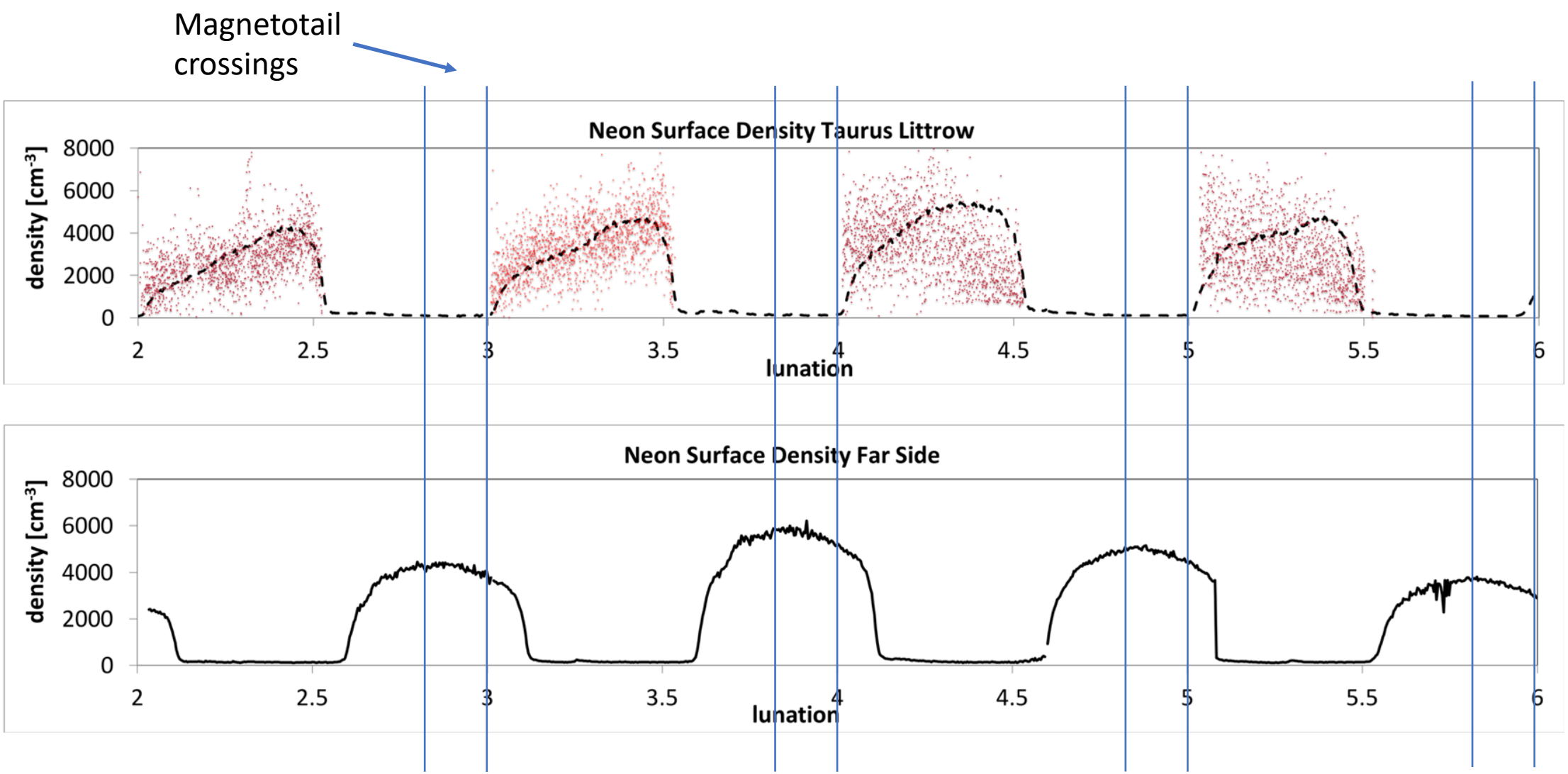


Magnetic Field

Proton density

Solar Wind Speed

He++/H+ Ratio


Magnetotail crossings
Neon Surface Density Taurus Littrow
density [cm-3]
8000
6000
4000
2000
0
2
2.5
3
3.5
4
4.5
5
5.5
6
lunation
Neon Surface Density Far Side
density [cm-3]
8000
6000
4000
2000
0
2
2.5
3
3.5
4
4.5
5
5.5
6
lunation

COMPARISON WITH OTHER OBSERVATIONS

- COOK ET AL., 2013 $4.4X10^{3}$ CM^{-3} LRO/LAMP
- BENNA ET AL, 2015 $2.0X10^{4}$ CM^{-3} LADEE

Comparison with CHANCE

(Chandra's Altitudinal Composition Explorer)

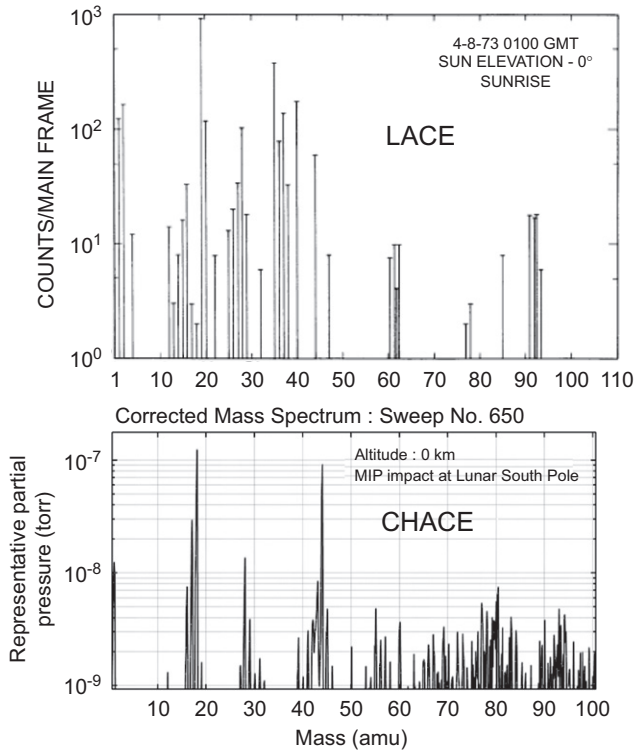


Fig. 10. Comparison between the mass spectra obtained by LACE in Apollo 17 mission (top) (Hoffman et al., 1973) and CHACE in Chandrayaan I mission (bottom). The former corresponds to over the surface, at equatorial region and sunrise time while the latter corresponds to close to the surface over south pole.

LACE, data obtained near the equator shows significant Neon.

CHANCE, data obtained at the South Pole to 50 S, shows no neon.

The dominant species are H_2O and CO_2

POSSIBLY ARTIFACTS?

They report a "clutter" of species near 80 AMU not seen by LACE, or reported as noise.

TWO POSSIBLE CONCLUSIONS

- THE DATA ARE CORRECT AND THE LIFETIME INTHE EXOSPHERE IS LESS THAN THE PHOTOIONIZATION LIFETIME
- THE DATA ARE INCORRECT AND THE LIFETIME COULD BE THE PHOTOIONIZATON LIFETIME

REMAINING QUESTIONS

- WHY DOES THE NIGHTSIDE NEON DECREASE SOMETIMES?
- WHAT IS THE TRUE LIFETIME OF NEON IN THE EXOSPHERE?
- WHAT DOES THE NEON EXOSPHERE LOOK LIKE ON THE DAYSIDE?