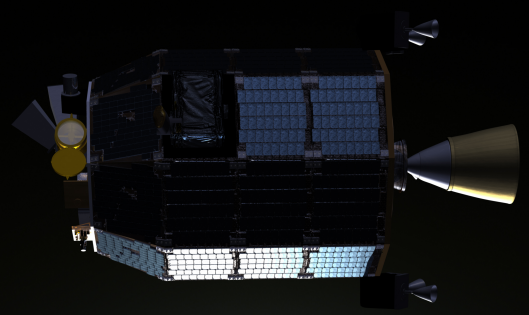
Hints of Low-Altitude Lunar Dust from the LADEE UVS data



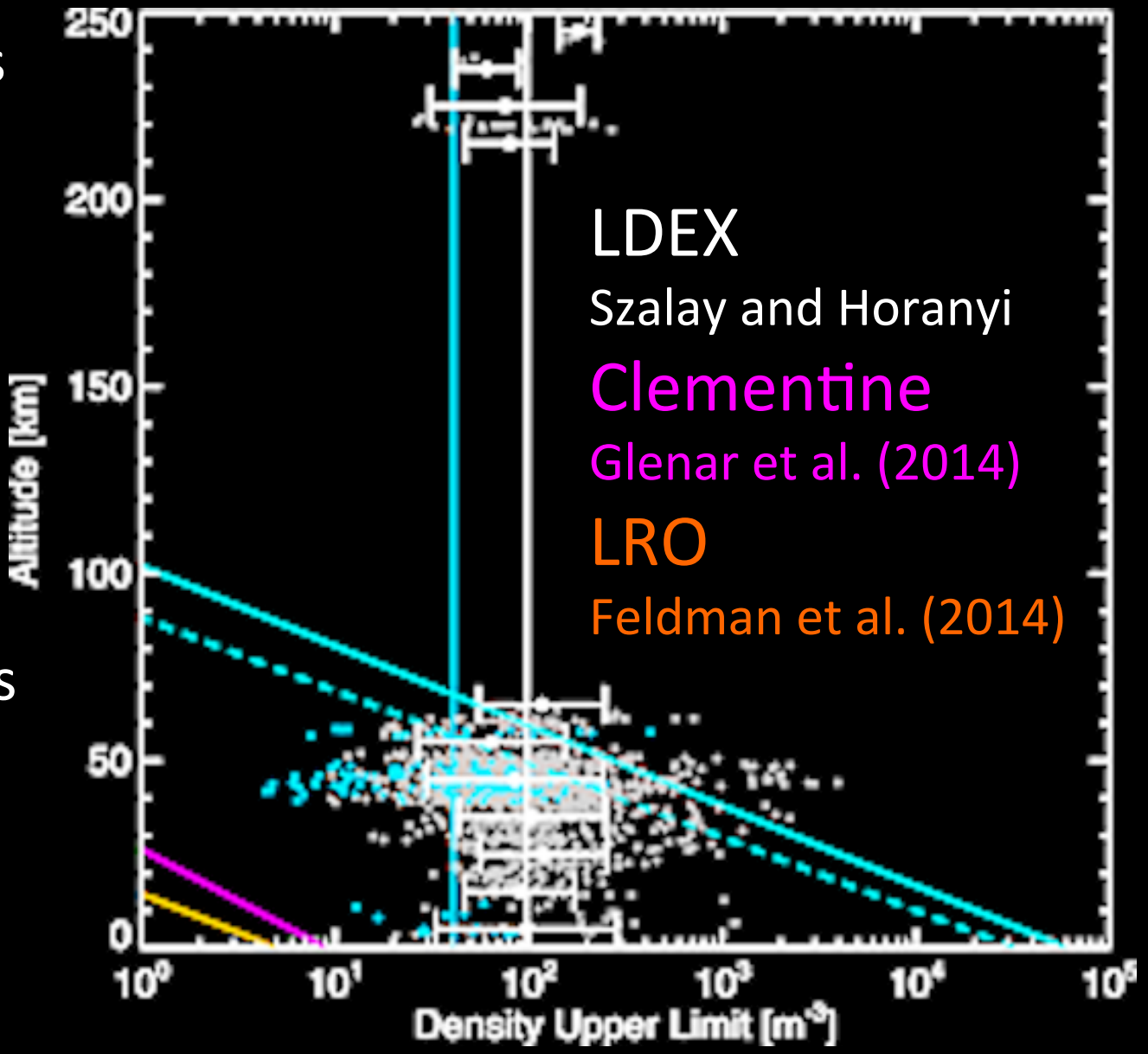
M.M. Hedman
D. Wooden, A. Cook
A. Colaprete

Image from NASA Ames

Existing measurements of dust above the Moon's surface.

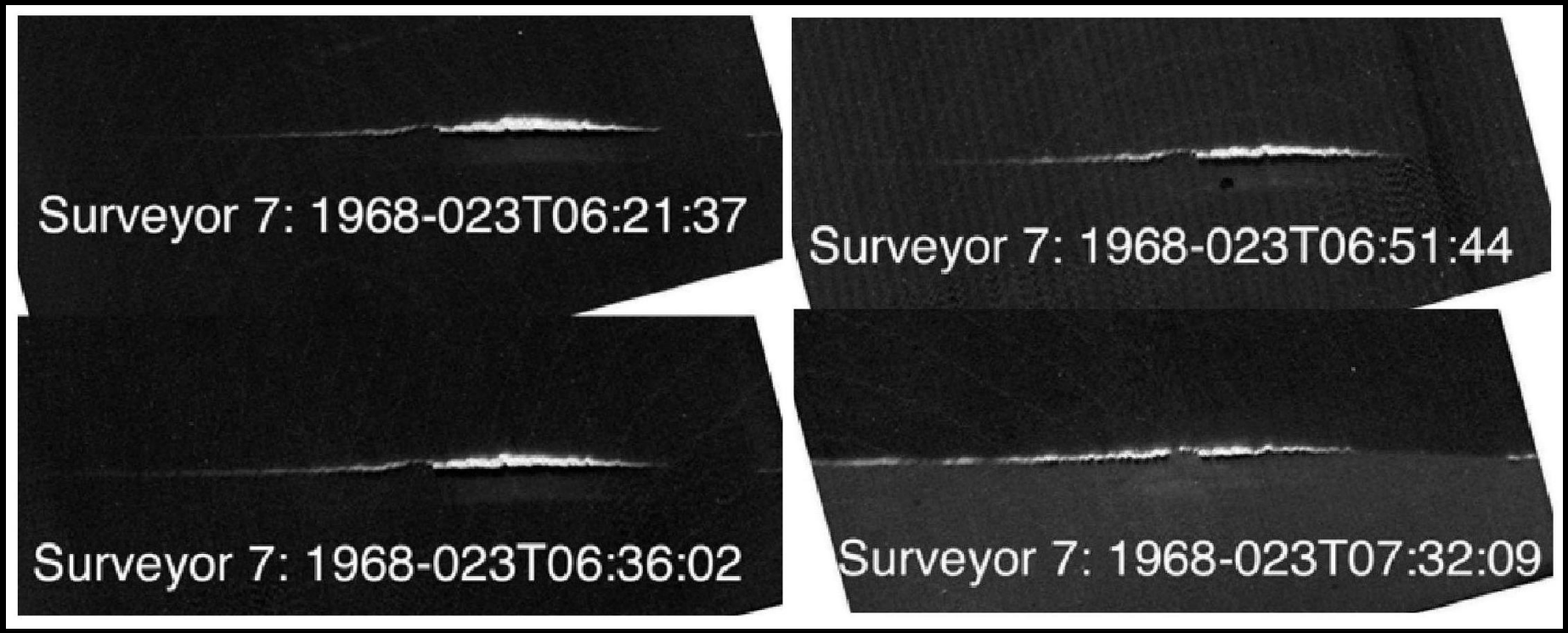
Multiple data sets show that the dust density is < 100/m^3 at altitudes > 1 km above the moon's surface

Such low densities are very difficult to detect by remote sensing.

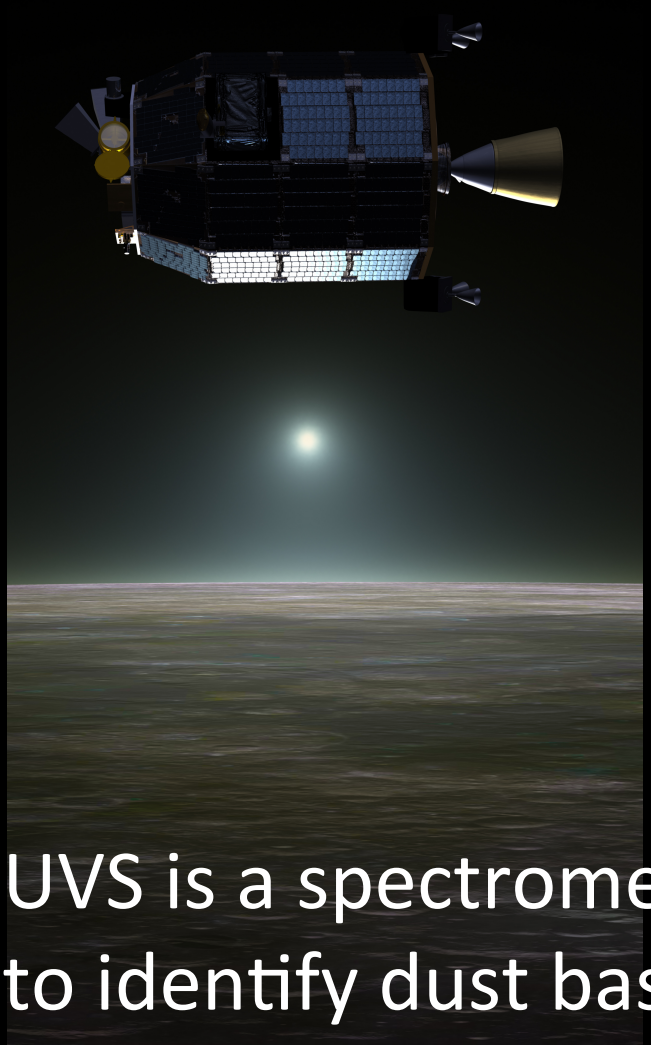


Szalay and Horanyi 2015

However, there is evidence for higher concentrations of dust within 1 km of the surface in the Surveyor data.



Is there any evidence of this low-altitude dust in the LADEE-UVS data?

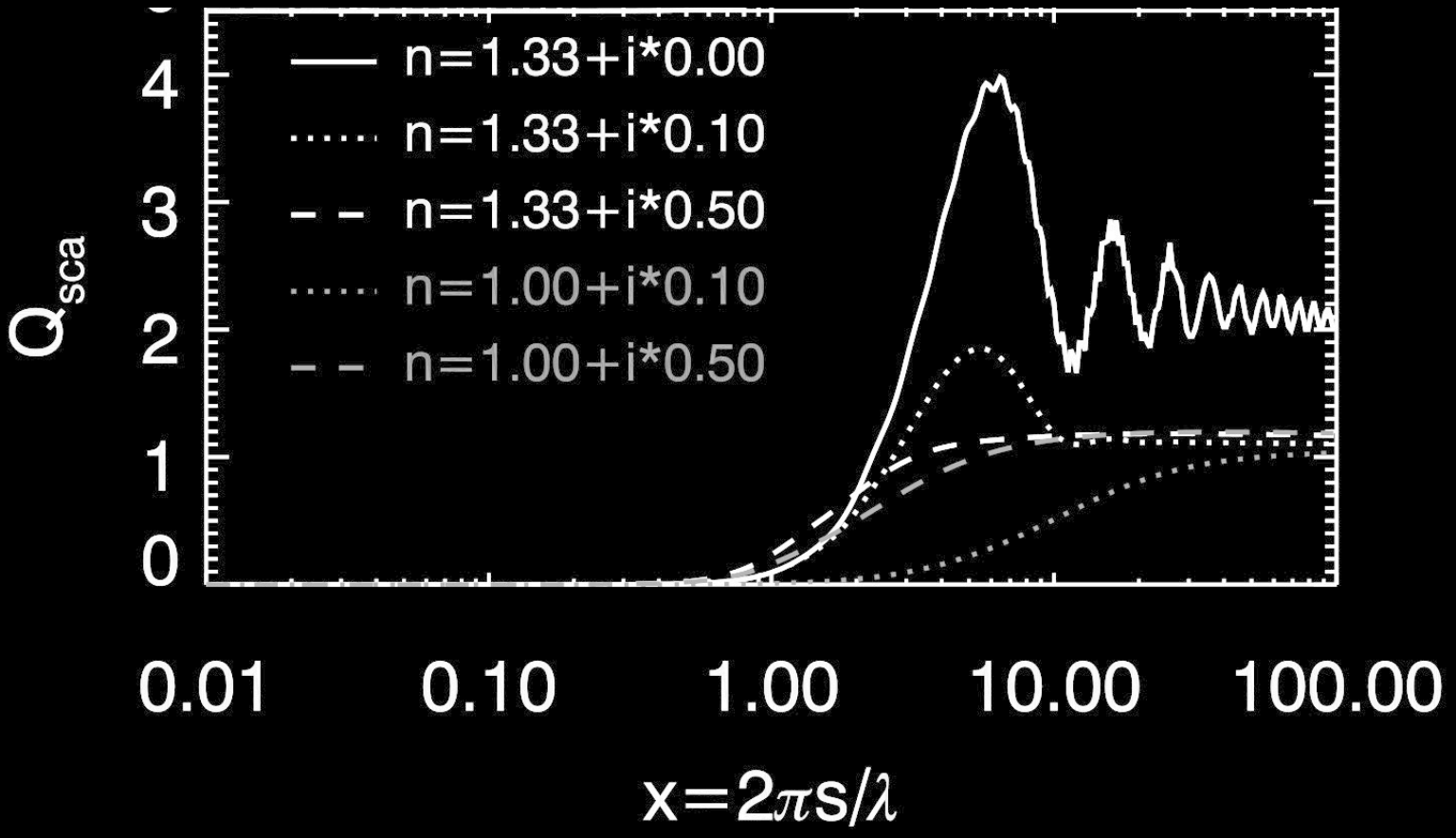


UV-Vis Spectrometer (UVS)

LCROSS heritage

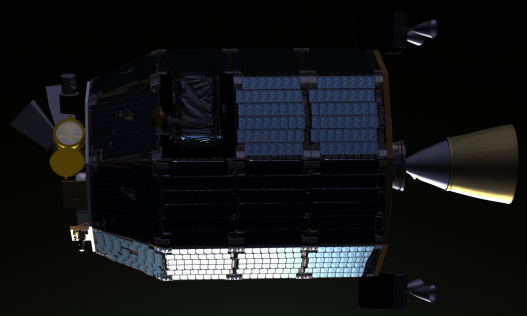
UVS is a spectrometer, not an imager, and so we need to identify dust based on its spectral properties

Particles of size s can only scatter light efficiently at wavelengths $\lambda < 2\pi s$



Sub-micron grains will produce blue signals

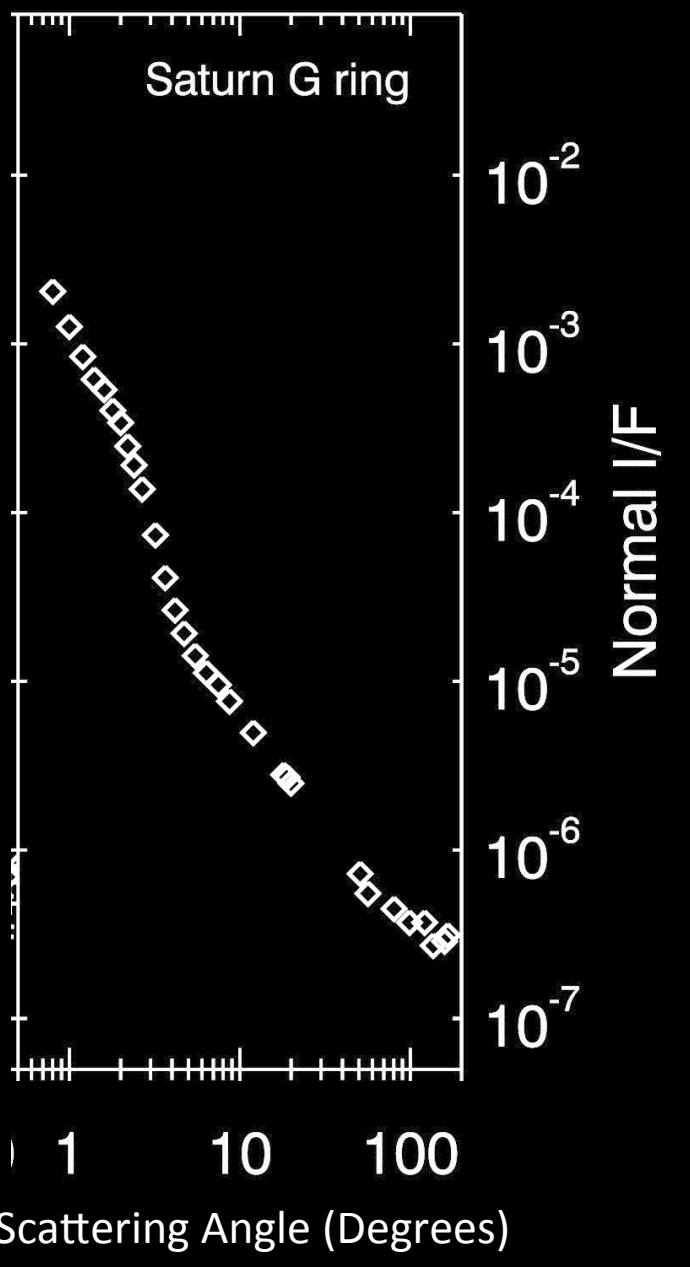
Dust is also forward-scattering, and so is easiest to see close to the Sun.



Relevant UVS observations:

--Solar Occultations

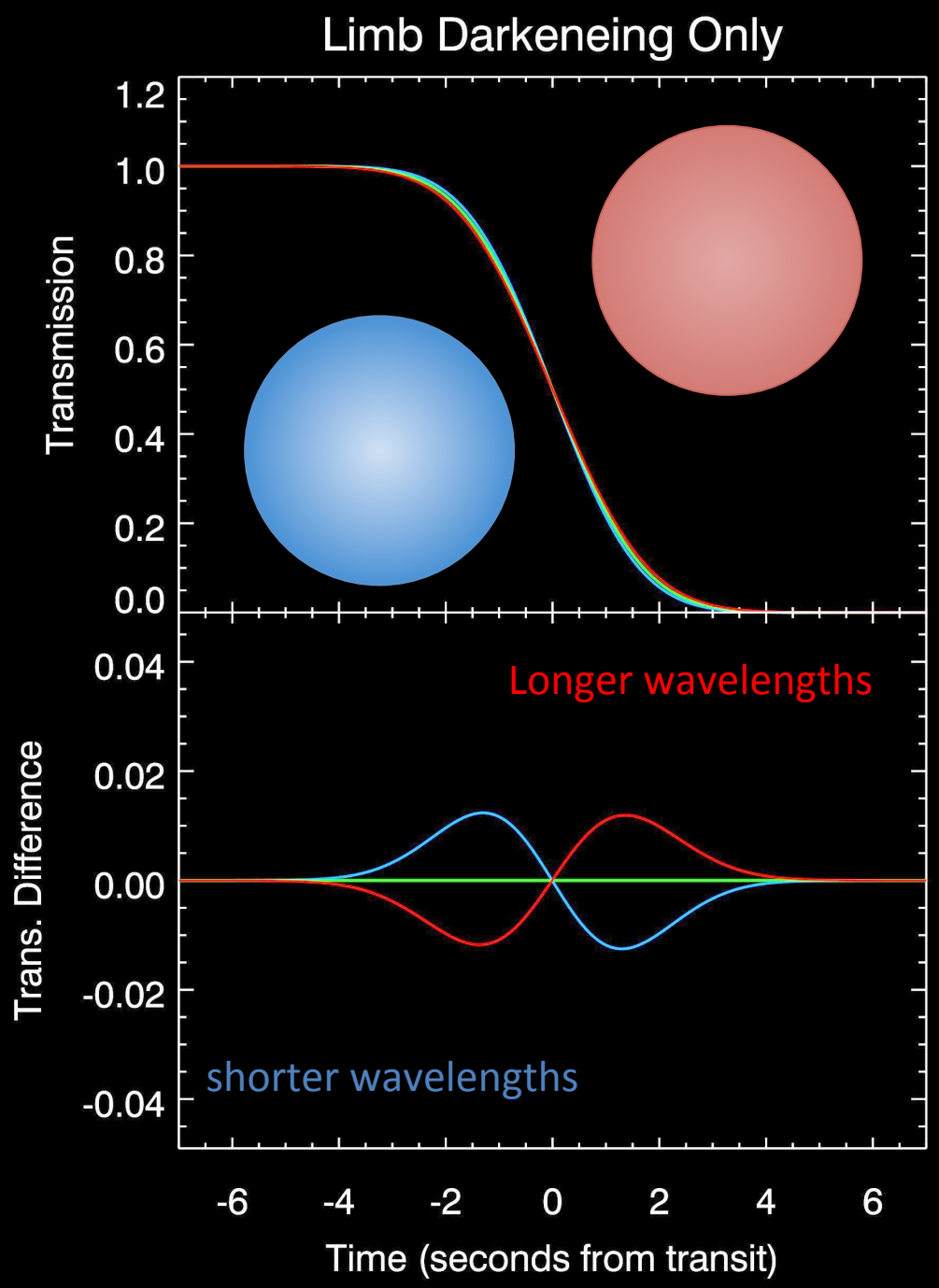
--Almost-Limb Observations



Expectations:

The Sun has more limb darkening at short wavelengths, so we expect that the light curve will be steeper at shorter wavelengths.

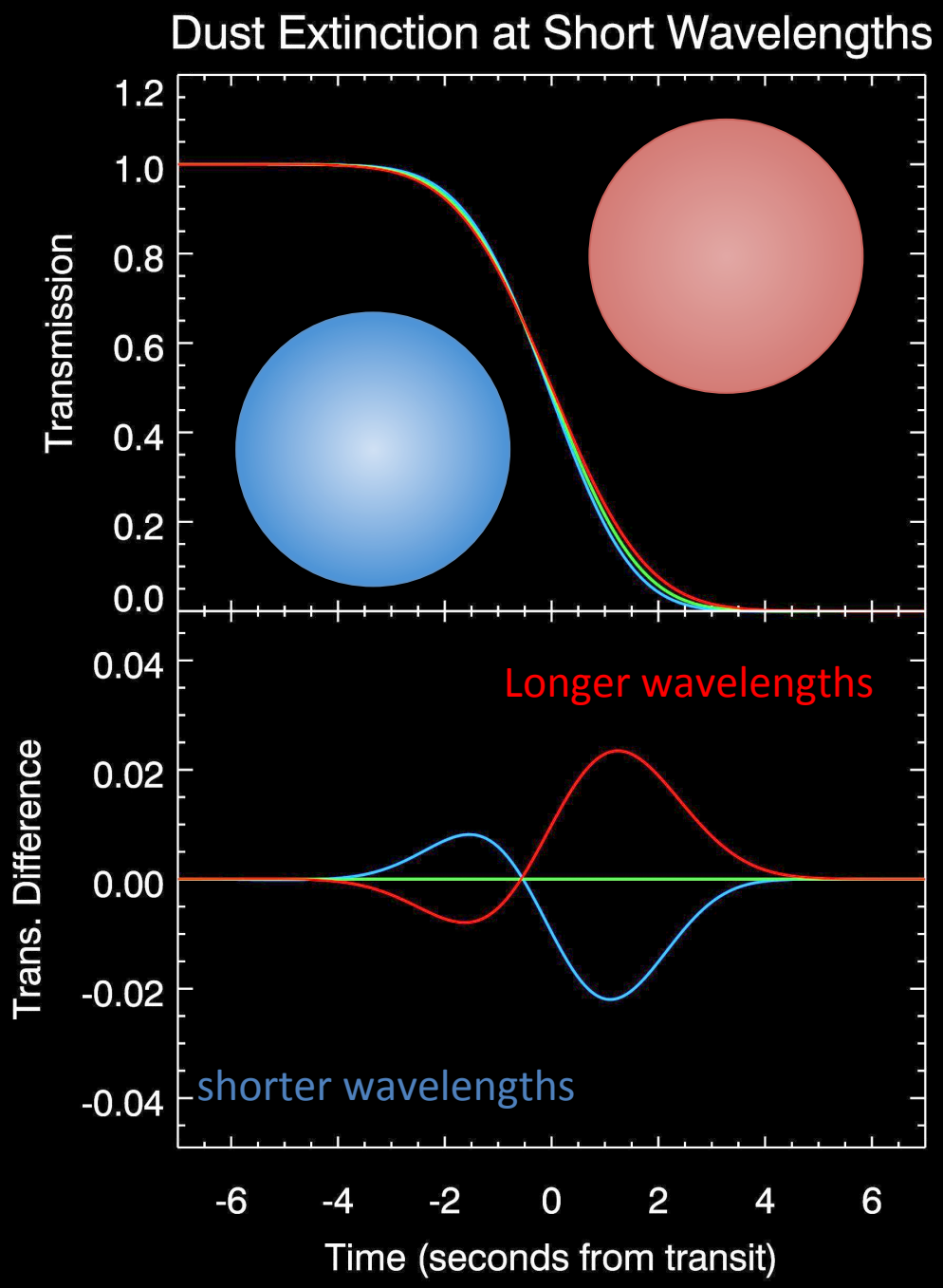
This effect can be most clearly seen by taking the differences between profiles at different wavelengths.



Expectations:

If there is also dust above the surface, it will preferentially scatter light at shorter wavelengths.

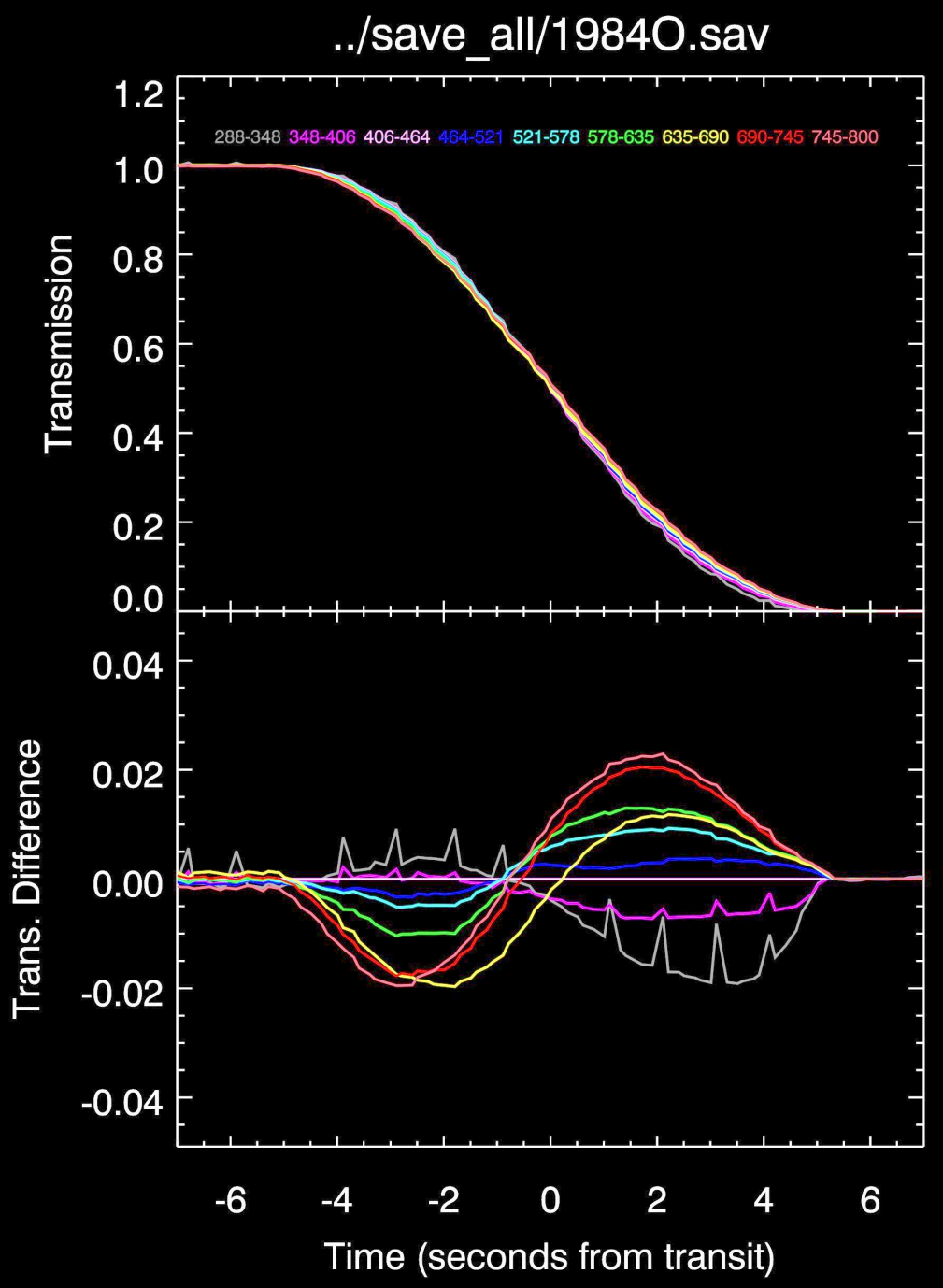
This will produce asymmetries in the difference light curves.



Observations:

The actual data show some asymmetries.

If this is due to dust, it would imply dust optical depths ~0.01 within 1 km of the lunar surface.



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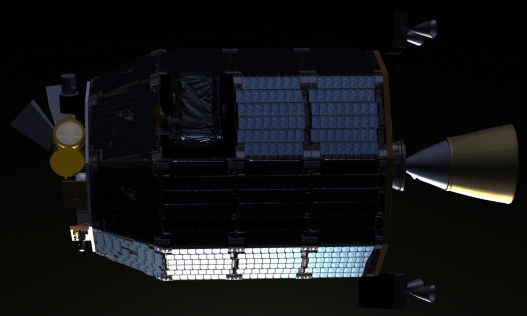

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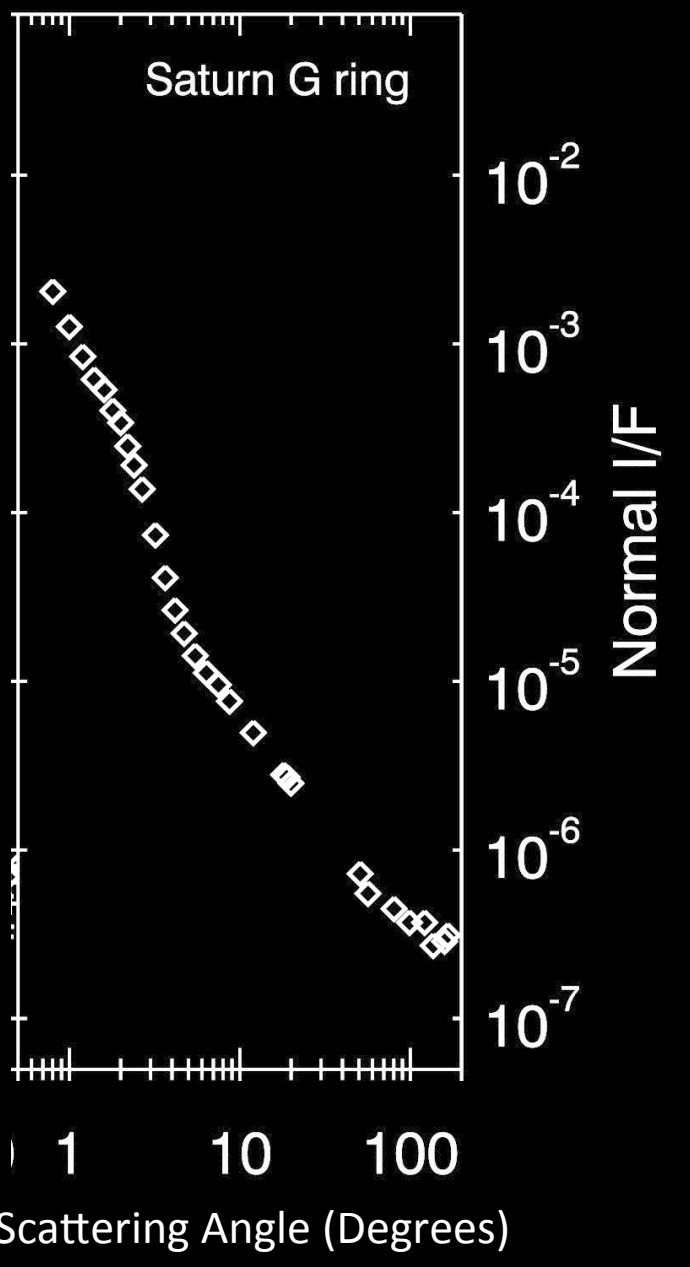
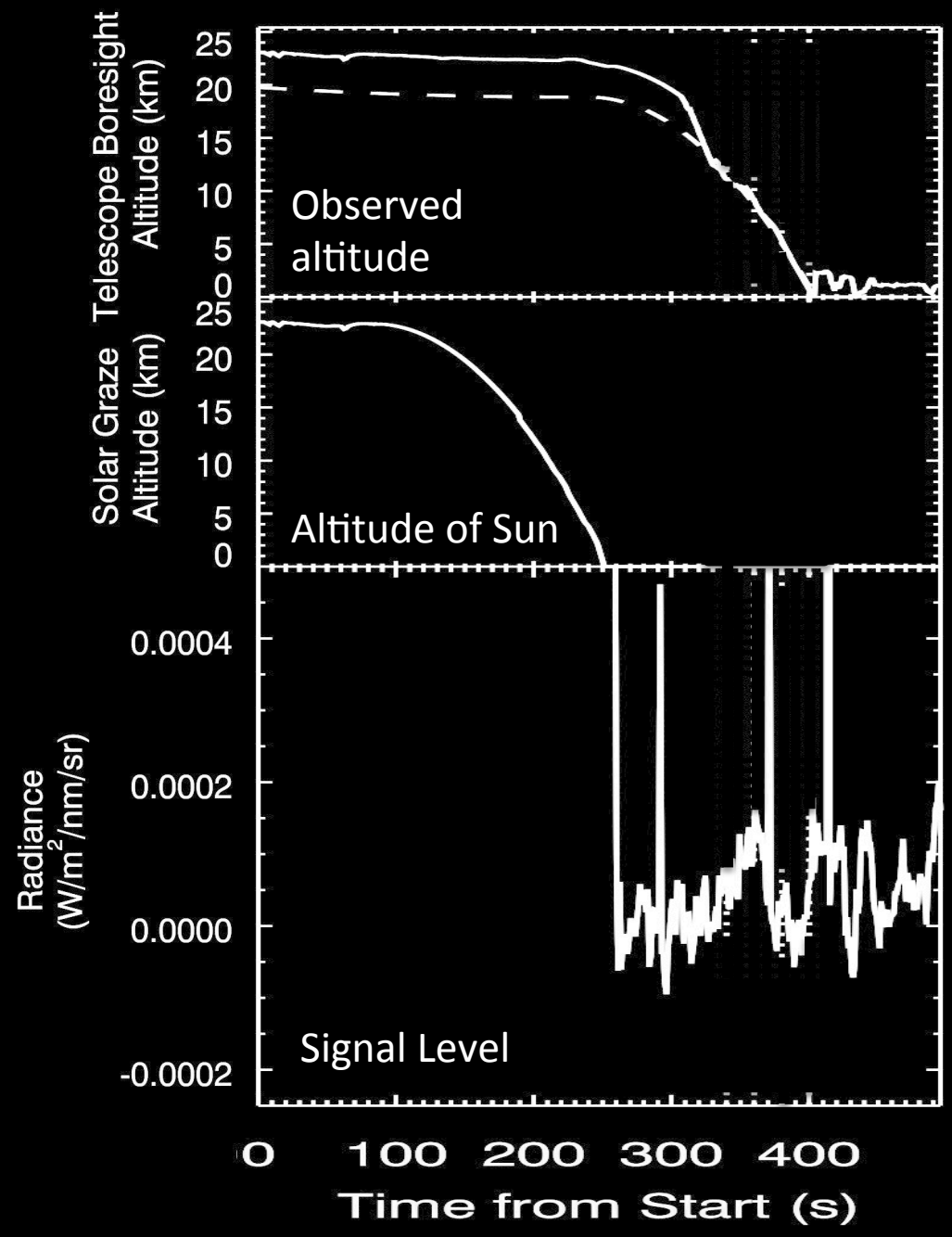


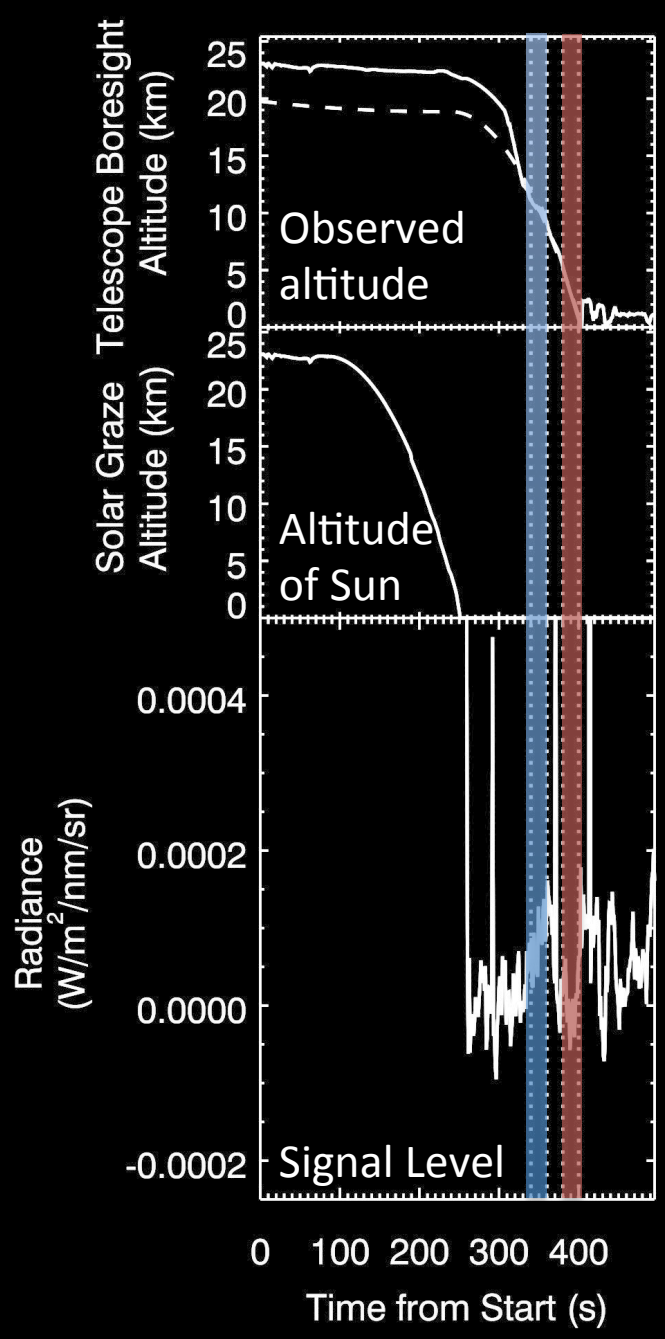


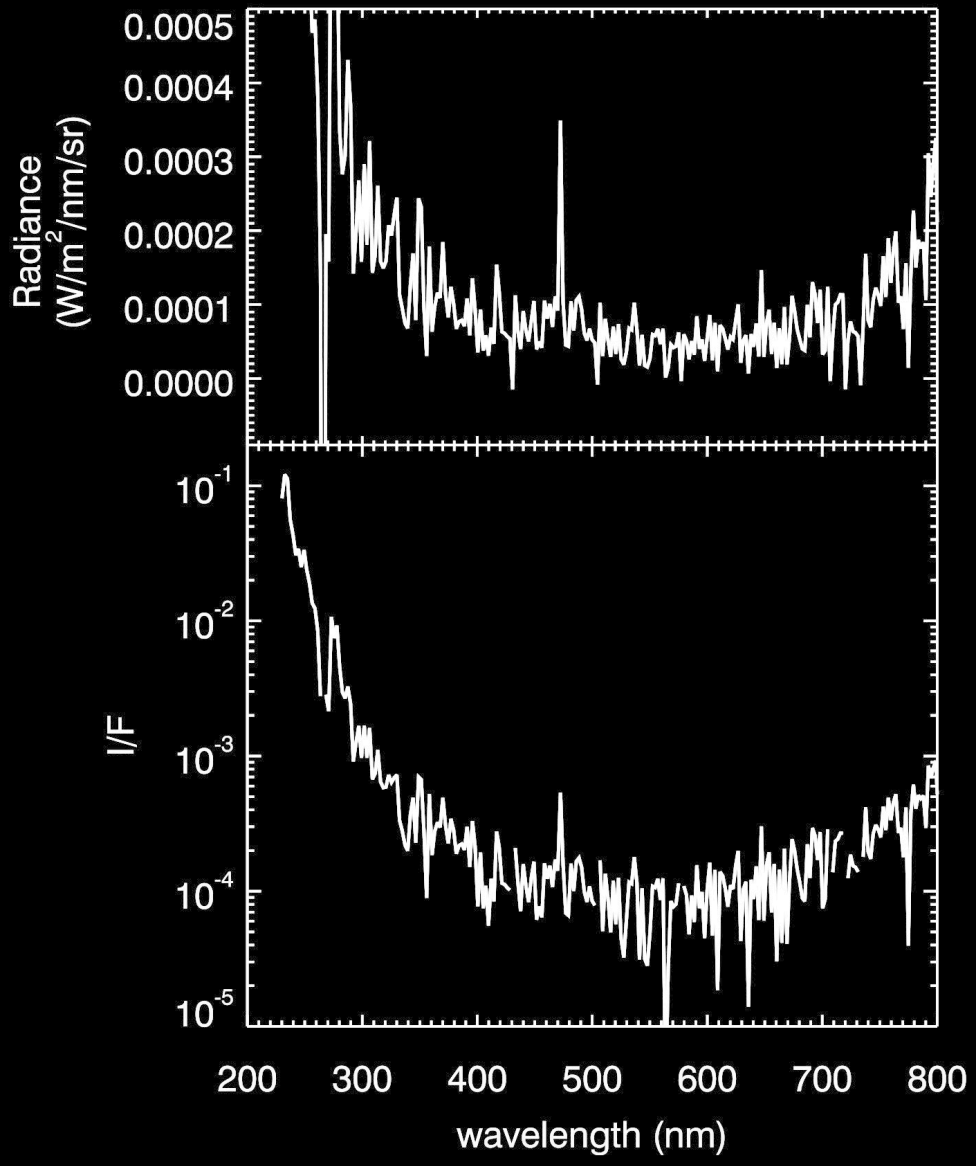
Signals in these data

Before the Sun sets, the signal is dominated by stray sunlight.

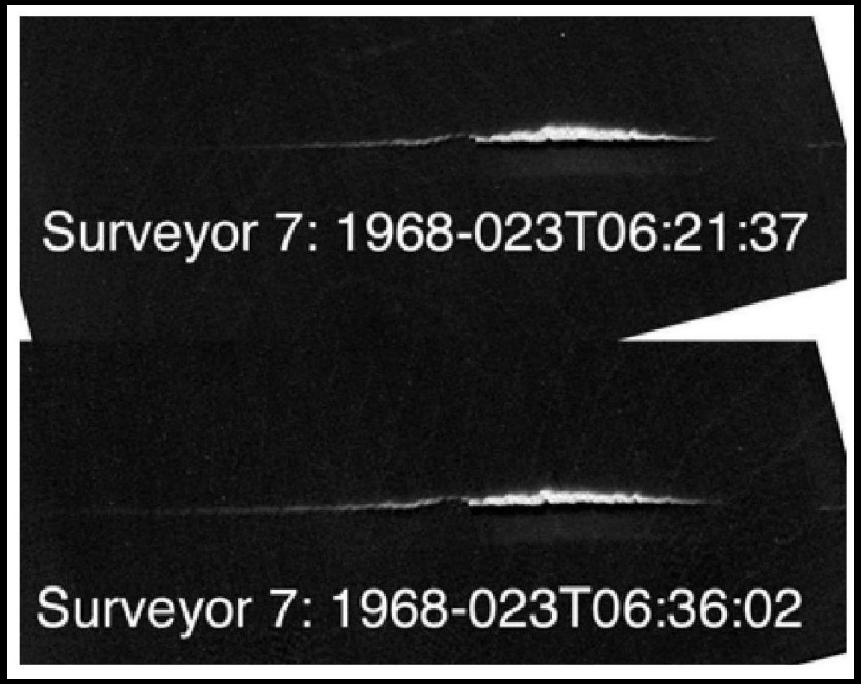
After sunset, there are still fluctuations in the signal level.

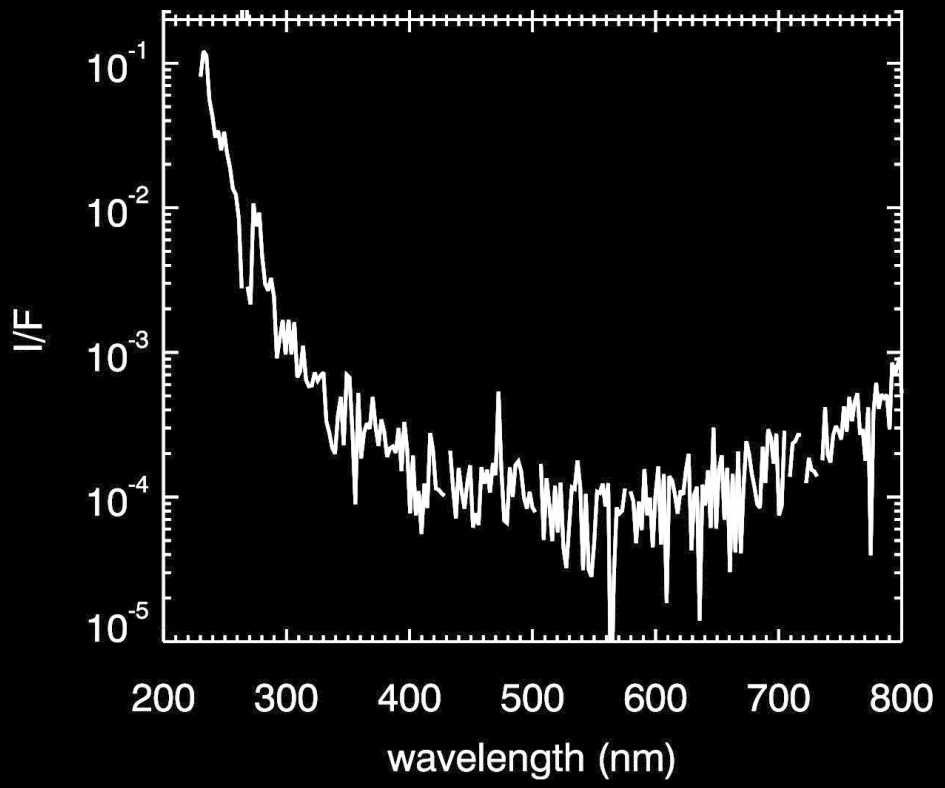
These signals have a blue color consistent with fine dust.





How do these numbers compare to Surveyor?





Rennilson and Criswell 1974

Scattering angle ~ 0.5^0

Peak Luminance = 0.26 cd/cm^2

Peak I/F ~ 0.006

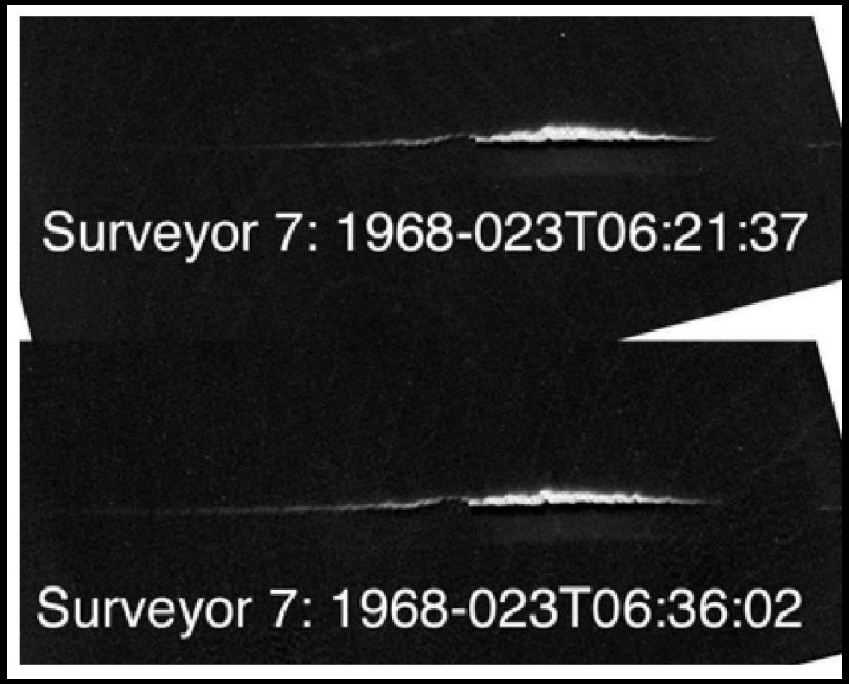
LADEE UVS

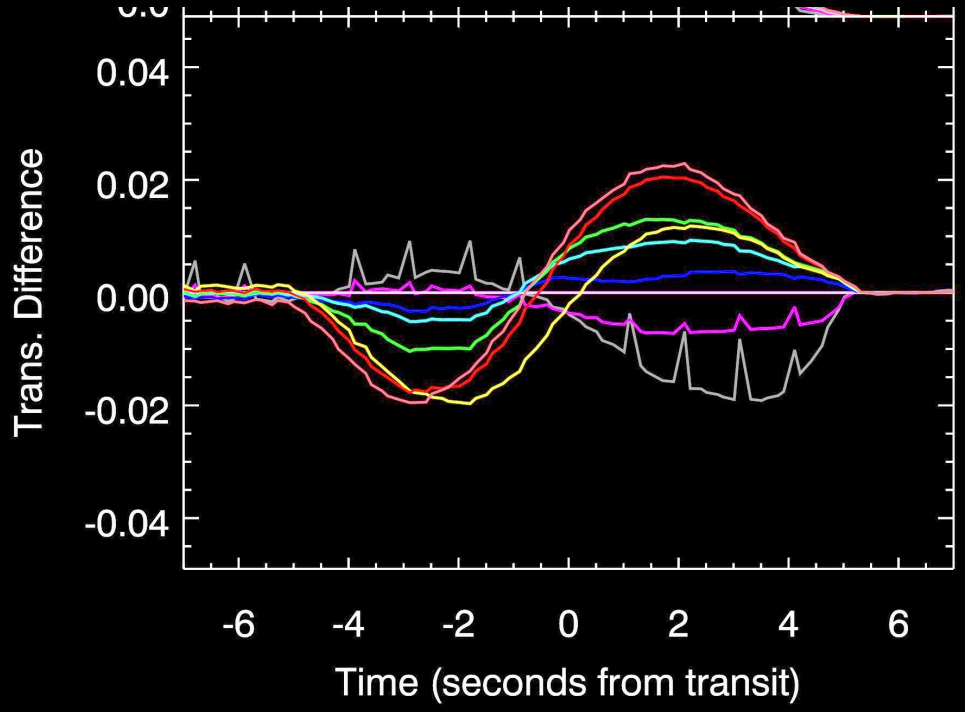
Scattering angle ~ 12^0

Peak radiance ~ 10^{-4} W/m^2/nm/sr

Peak I/F ~ 0.001 -0.0001

How do these numbers compare to Surveyor?





Rennilson and Criswell 1974

Scattering angle ~ 0.5^0

Peak Luminance = 0.26 cd/cm^2

Peak I/F ~ 0.006

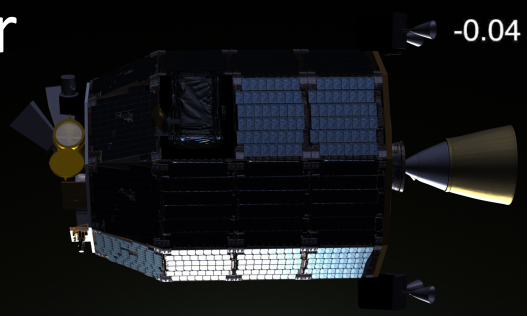
LADEE UVS

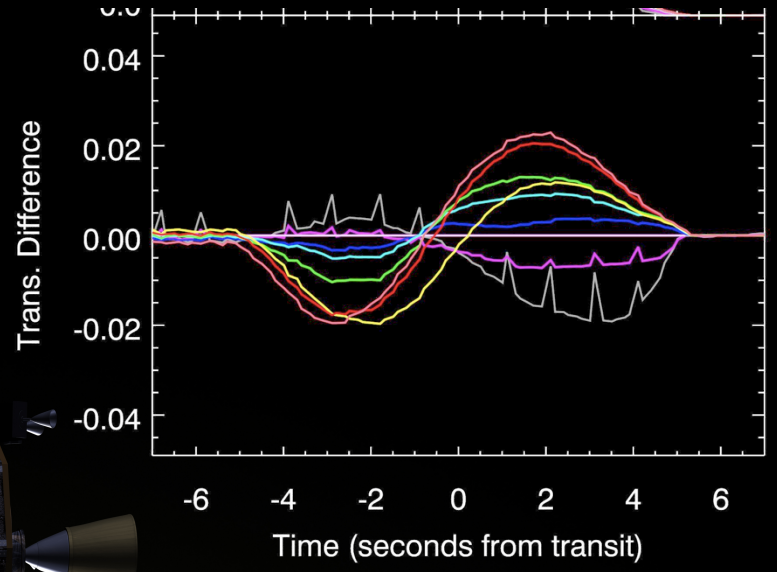
Optical depth ~ 0.01

This will work if particles are mostly sub-micron in size.

Next Steps:

1. Compare Surveyor and LADEE-UVS data with proper light-scattering codes





2. Use topographic models to predict when dust signal should be visible