# The Search for a Diurnal Effect in Lunar Hydrogen Abundance

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Mapping the abundance of hydrogen-bearing materials has led to significant advances in our understanding of the sequestration of volatiles at the poles of the Moon. Neutron spectroscopy, and especially mapping of epithermal neutron fluxes, has been central to this endeavor [e.g. 1]. In this talk we present a study of the diurnal variation of the Lunar Prospector neutron spectrometer (LPNS) measurements to search for the possible low-latitude mobility of water molecules. This study is prompted by reports of local-time-varying concentrations of $H_2O$/OH, based on near-infrared spectral reflectance data [e.g. 2], as well as reports of a diurnal hydrogen signature in the Lunar Exploration Neutron Detector epithermal neutron fluxes [e.g. 3]. While the spectral reflectance signatures could be due to small amounts of surficial water or hydroxyl molecules within the instrument view, the neutron result implies the diurnal mobility of volumetrically significant amounts of water and/or hydroxyl. Such an extraordinary finding, if confirmed, could have significant ramifications for our understanding of the $H_2O$/OH distribution and mobility at the lunar surface.

To quantify the variability of the epithermal count rate, $cr(\mathbf{x}, t)$, we introduce the random *over count rate* variable, $\delta cr(\mathbf{x}, t)/cr$:

$$\delta cr(\mathbf{x}, t)/cr = (cr(\mathbf{x}, t) - cr_f(\mathbf{x}, t))/cr_f(\mathbf{x}, t))$$

where $cr_f(\mathbf{x}, t)$ is the fiducial count rate maps at 6 pm (local time), $\mathbf{x}$ is the a location on the lunar surface and $t$ denotes local time. To quantify $cr(\mathbf{x}, t)$ we use three sub time-series defined as follows: *i)* All the instants of the overall LPNS time-series within the latitude range $[-55°, -55°]$, *ii)* measurements with high altitude (average $\sim$ 100km) at the same latitude range as the previous data-set (hereafter High Altitude), and *iii)* measurements with low altitude (average $\sim$ 30km) at $|\text{latitude}| < 55°$ (hereafter Low altitude). In Figure 1 we show the average *over count rate* (averaged over the latitude domain) of the three sub time-series. In this talk, we will show that Lunar Prospector epithermal neutron data exhibit diurnal variations of the same magnitude (1-2% of the average lunar epithermal neutron flux) as those reported by [3], however the LPNS variations do not follow the same diurnal trend. Instead, the LPNS variations are systemically anti-correlated with instrument temperature, and are related to very small changes in instrument gain. These findings suggest that, rather than reflecting diurnal changes in hydrogen, the temporal fluctuations in the count rates are due to small residual systematic effects in the data reduction.

## References

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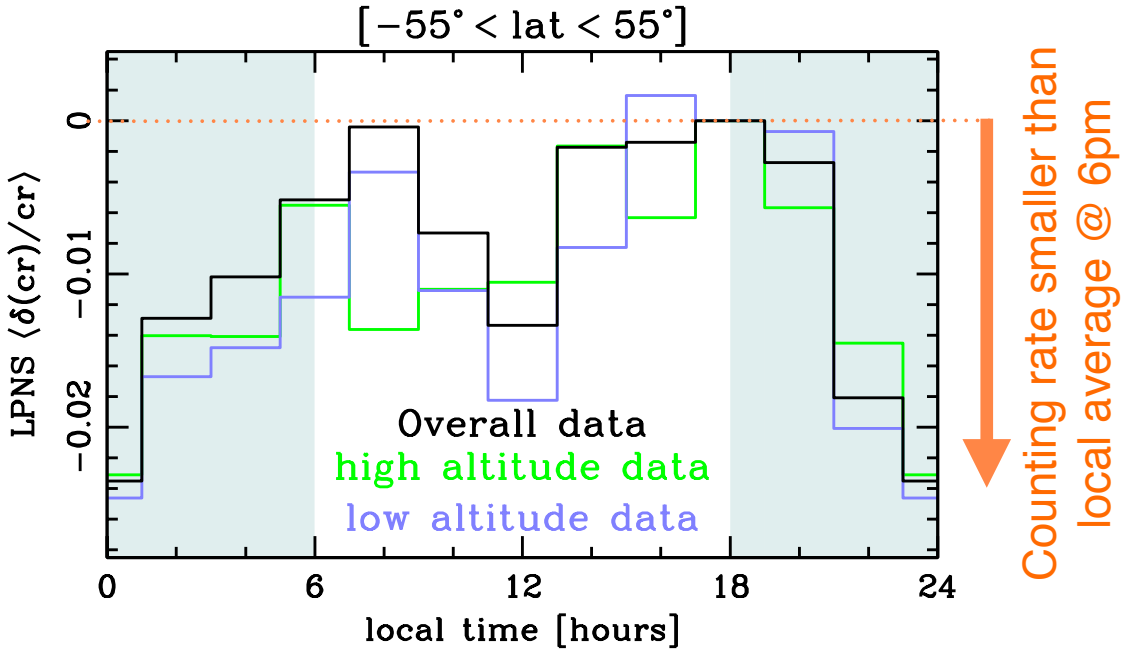


Figure 1: Average *over count rate* per *local time* bin. The *fiducial map* is the mean counting rate at a given location over a two hour local time bin centered around 6 pm local time. The random errors in the measurements are smaller than $2.1\times10^{-4}$, $5.2\times10^{-4}$, $3.5\times10^{-4}$ for the overall (black), high altitude (green) and low altitude (violet) data, respectively. The shaded regions of the diagrams represent the night period of the day. The $x$-axis tickmarks coincide with the local time bin centers.

Mitrofanov, W. V. Boynton, L. G. Evans, M. L. Litvak, T. P. McClanahan, A. B. Sanin, and R. D. Starr. Evidence for Diurnally Varying Hydration at the Moon's Equator from the Lunar Exploration Neutron Detector (LEND). In *Lunar and Planetary Science Conference*, volume 45 of *Lunar and Planetary Science Conference*, page 1507, March 2014.