Submillimeter Remote Sensing of Planetary and Cometary Atmospheres and LRO/LCROSS Observations of the Moon

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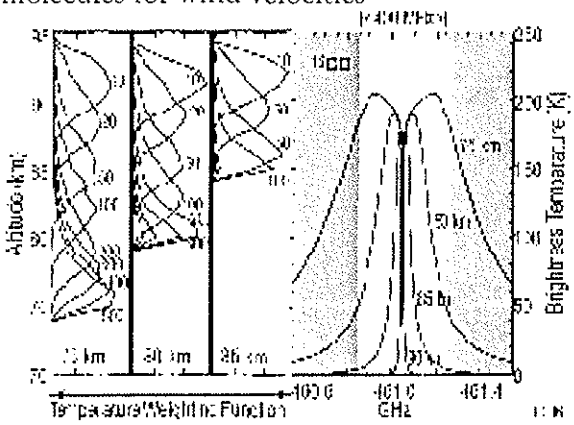
Submillimeter Remote Sensing

Submillimeter remote sensing of planetary and cometary atmospheres have been proposed for Venus and Mars while MIRO on Rosetta will observe the coma of Comet 67P/ Churyumov – Gerasimenko in December 2015. UARS and AURA MLS have observed millimeter and submillimeter molecule emissions in the Earth's stratosphere for many decades.

Observations of submillimeter wave molecular emissions provide a wealth of information not obtainable by alternative techniques. Submillimeter line emissions exhibit linear temperature dependence, insensitivity to aerosol scattering, extinction, and have separated transitions with well-determined line-shapes. These observations have high sensitivities to trace chemical species and can; 1) Fully resolve the line profiles of molecules with high resolution, 2) Provide deterministic retrievals of species abundance, temperature, and pressure, and 3) Measure Doppler shifts of detected molecules for wind velocities



Limb Profile of ^{12}CO for Venus.

Modern submillimeter receivers have ±30 GHz tunability covering many molecular species. A limb viewing geometry and stable receiver operation permits long integration to detect trace species. These observations can also detect key isotopologues.

LRO/LCROSS Observations

The combined observations from the LCROSS and LRO missions of the plume blasted into view by the spent Centaur upper stage of the Atlas rocket that propelled both spacecrafts to the Moon, offer a complex new view of the volatile inventory embedded in the lunar regolith.

The LCROSS mission was guided by the objective of providing direct proof of water ice in the cold dark cold traps in lunar Permanently Shadowed Regions. The LCROSS target was the Cabeus crater near the South Pole where LRO LEND had detected high concentrations of hydrogen and LRO Diviner measured extremely cold surface temperatures.

The shepherding spacecraft, with nine instruments, observed the impact remotely as it followed the Centaur towards the surface that left a 25- to 30- meter diameter crater and then flew through the ejected debris, dust, and vapor. The LCROSS NIR, ultraviolet cameras and spectrometers reported detection of water vapor and ice (about 155 ± 12 kilograms), and features attributable to hydroxyl, hydrocarbons and sulfur-bearing species, and carbon dioxide.

Overhead in its 50-km orbit, the LRO spacecraft adjusted its orbit so that its closest approach to the LCROSS target site occurred 90 secs after impact.

The spacecraft rolled from nadir so that the LAMP instrument FOV's sighted just above the limb. LAMP succeeded in detecting molecular hydrogen, carbon monoxide, atomic mercury with contributions from calcium and magnesium.

LRO Diviner independently maneuvered its FOV to observe the impact site and was successful in observing the thermal signature and evolution of the heated crater 90 secs, 2- and 4- hours after the LCROSS impact.