SUBMILLIMETER SOLAR OBSERVATION LUNAR VOLATILES EXPERIMENT (SSOLVE), A SPECTROMETER TO MEASURE WATER VAPOR IN THE LUNAR EXOSPHERE. T. A. Livengood[1,2,3], C. M. Anderson[2], B. T. Bulcha[2], G. Chin[2], N. Ehsan[2], T. Hewagama[2], P. E. Racette[2]. [1]Astronomy Dept, U of MD, College Park, MD, tlivengo@umd.edu; [2]NASA Goddard Space Flight Center, Greenbelt, MD; [3]Center for Research and Exploration in Space Science and Technology (CRESST).

The Submillimeter Solar Observation Lunar Volatiles Experiment (SSOLVE) overcomes the challenges of site contamination to measure small quantities of water vapor by distinguishing water in the exosphere from water local to the instrument. SSOLVE will resolve the broad uncertainty in water abundance in the lunar atmosphere and processes for its supply, removal, and relocation across the surface. Water at the Moon could be delivered by solar wind or meteoroids or it could be indigenous, with implications for the Moon's formation history and evolutionary processes. The key to distinguishing the source of lunar water and processes controlling it is the present abundance of water in the exosphere and its diurnal variability. SSOLVE can make these measurements with high sensitivity and precision.

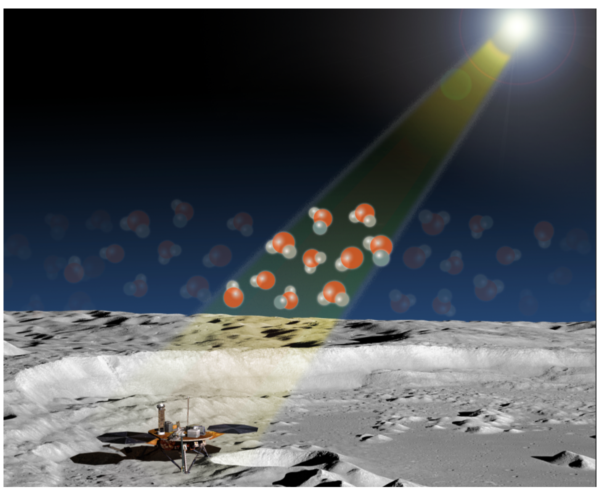

Fig. 1: SSOLVE will measure lunar water vapor against the bright Sun. SSOLVE will operate submillimeter spectrometers from a lander, using a heliostat to target the Sun and to measure the column abundance of H_2O, OH, and HDO in the lunar atmosphere.

SSOLVE relies on the Sun as a backlight to illuminate the presence of water in the tenuous lunar atmosphere: its abundance, diurnal variability, chemical state (H_2O vs. OH), and the balance between sources and loss (Fig. 1). Water is critical to understanding lunar formation, the interaction between rocky bodies and space, and the potential for in situ resource utilization (ISRU) in lunar exploration and beyond. The SSOLVE design employs two bore-sighted heterodyne spectrometers: one spectrometer detects the 557 GHz transition of H_2O and the 509 GHz transition of HDO; the other spectrometer detects the 2510 GHz transition of OH. Doppler broadening in the absorption lines will measure the translational temperature of the gas to determine whether it is thermally accommodated to the local surface temperature as usually assumed. A sun-tracking scanner (heliostat) acquires and tracks the Sun regardless of platform orientation, as well as enabling measurements on dark sky and on calibration targets. A radome and enclosure shields the optics from dust and visible-wavelength light to enable staring at the Sun.

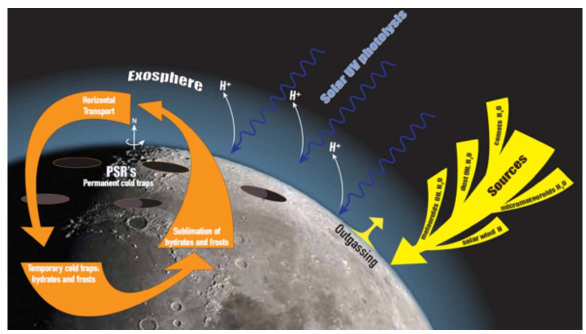

Fig. 2: SSOLVE measures water vapor to learn which source of water dominates the lunar atmosphere. The global inventory of water in the atmosphere/exosphere is in equilibrium between input sources (yellow) and losses to space and (potentially) permanent cold traps at the poles. Molecules migrate from the warm daylight surface across the terminator to be temporarily trapped on the cold night-time surface until the Moon's rotation brings hydrated surface into daylight to thermally desorb volatiles into the atmosphere, completing a hydration cycle (orange).

SSOLVE measures the total column of H_2O and OH above the lunar surface, in comparison with calibration measurements to eliminate local contributions to water vapor in the line of sight. SSOLVE uses high spectral resolution to definitively identify transitions of H_2O, OH, and HDO, to measure abundance, and to characterize physics in the exosphere using Doppler linewidth from translational motion.

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