The Lunar Ice Cube Mission in Development.

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Overview: Lunar Ice Cube will be deployed in cis-lunar space in 2019 by NASA's EM1 mission. Lunar Ice Cube was selected by the NASA HEOMD NextSTEP program to demonstrate cubesat propulsion (Busek BIT 3 RF Ion engine), and a cubesat-scale instrument capable of addressing Strategic Knowledge Gaps related to lunar volatile distribution (abundance, location, and transportation physics of water ice). We will also demonstrate for the first time in deep space an inexpensive radiation-tolerant flight computer (Space Micro Proton 400K), the GSFC Core Flight Executive Operating System, a custom pumpkin power system, and AIM/IRIS microcryocooler.

Payload: The payload consists of one instrument: BIRCHES [1], Broadband IR Compact High-resolution Exploration Spectrometer. The versatile instrument, being developed by NASA GSFC, is designed to provide the basis for amplifying our understanding [2,3,4] of the forms and sources of lunar volatiles in spectral, temporal, spatial, and geological context as function of time of day and latitude. BIRCHES is a compact version (1.6 U, 3 kg, 10-20 W) of OVIRS on OSIRIS-REx [5], a point spectrometer with a cryocooled HgCdTe focal plane array for broadband (1 to 4 micron) measurements. The instrument will achieve sufficient SNR (>100) and spectral resolution (</= 10 nm @ 3 microns) through the use of a Linear Variable Filter to characterize and distinguish spectral features associated with water. An adjustable field stop allows as to change the footprint dimensions by an order of magnitude, to adjust for variations in altitude and/or incoming signal. The compact and efficient AIM microcryocooler/IRIS controller is designed to maintain the detector temperature below 115K.

Investigation: Radiometric models for our instrument configuration indicate that lunar surface emission does not become significant at temperatures within the instrument according to our thermal models until beyond the three-micron band. Emission from detector surfaces remains a minor component regardless of wavelength. These models also allow us to remove thermal emission as a function of wavelength. In addition, for the three-micron band, we should have adequate signal to noise ratio (SNR) to see the absorption features even as we approach the terminator as long as we have water at the hundredths of a percent level or above.

Mission Design: Science data-taking with the BIRCHES payload will occur primarily during the science orbit (100 km x 5000 km, equatorial periapsis, nearly polar), highly elliptical, with a repeating coverage pattern that provides overlapping coverage at different lunations. Particular attention will be paid to systematic or solar activity dependent transient effects resulting from charged particle interactions around the terminators. Science orbit data-taking will last approximately 6 months, 6 lunar cycles, allowing for sufficient collection of systematic measurements as a function of time of day to allow derivation of volatile cycle models.

References: [1] Clark P.E. et al. (2017) SPIE Proceedings 9978, 99780C; [2] Pieters C. et al. (2009) Science, 326, 568-572; [3] Sunshine J. et al. (2009) Science, 326, 565-578; [4] Colaprete A. et al. (2010) Science, 330, 463-468; [5] Reuter, D. and A. Simon-Miller, (2012) Lunar and Planetary Science, 1074.pdf.