THE MOON AND ASTEROIDS ACROSS THE THERMAL INFRARED. K. L. Donaldson Hanna[1,2], B. T. Greenhagen[3] and N. E. Bowles[2], [1]Department of Physics, University of Central Florida, Orlando, Florida, USA (Kerri.DonaldsonHanna@ucf.edu), [2]Atmospheric, Oceanic and Planetary Physics, University of Oxford, Oxford, UK, [3]Johns Hopkins Applied Physics Laboratory, Laurel, Maryland, USA.

Introduction: The surfaces of most Solar System airless bodies (i.e., the Moon, asteroids, Mercury, Phobos, and Deimos) are dominated by particulate regolith materials. The emitted radiation that we measure remotely originates from the upper hundreds of microns of regolith of these airless bodies. Early laboratory studies and radiative transfer modeling demonstrated that the vacuum environment in the near-surface regolith of airless bodies creates a thermal gradient, which causes known spectral features to shift position and change in contrast [e.g., Logan and Hunt, 1970; Salisbury and Walter, 1989; Henderson and Jakosky, 1994]. The thermal gradient and how much these spectral features shift and change in contrast are governed by key regolith properties including composition, albedo, particle size, and porosity [e.g., Logan et al., 1973; Salisbury et al. 1991; Donaldson Hanna et al., 2017; 2019].

Thus, to better interpret thermal infrared (TIR) remote sensing observations of Solar System airless bodies, we need laboratory measurements of analog materials measured under the appropriate near-surface conditions. Here we present laboratory TIR emissivity spectra of bulk lunar soils and asteroid analogs measured under lunar- and asteroid-like conditions and discuss the implications for the interpretation of remote sensing observations to better constrain composition and physical properties.

Experimental Set-up: Near-surface environments for the Moon and asteroids can be simulated using the Planetary Analogue Surface Chamber for Asteroid and Lunar Environments (PASCALE). The vacuum environment chamber is located within the University of Oxford and is capable of simulating near-surface conditions for a range of airless bodies by varying the atmospheric pressure inside the chamber and the incident solar-like irradiation on the sample [Donaldson Hanna et al., 2019]. By varying the near-surface environment, the thermal gradient in the upper hundreds of microns of the sample is varied, which affects the position and contrast of diagnostic features in TIR spectra [e.g., Logan et al., 1973; Salisbury et al. 1991; Donaldson Hanna et al., 2017; 2019]. PASCALE is attached to a Bruker VERTEX 70V Fourier Transform Infrared (FTIR) spectrometer capable of measuring thermal infrared wavelengths (~5-50 microns).

We simulate lunar-like conditions in PASCALE by removing atmospheric gases within the chamber (pressure < 10^{-4} mbar), heating the sample from below to 353K, and heating the sample from above until the estimated brightness temperature of the sample is ~390K. We simulate asteroid-like conditions by removing atmospheric gases within the chamber (pressure < 10^{-4} mbar), heating the sample from below to 353K, and heating the sample from above until the estimated brightness temperature of the sample is ~350K.

Results and Conclusions: Laboratory measurements of lunar soils and carbonaceous chondrite meteorites presented here show the dramatic effects of albedo on TIR spectra. These results suggest that the thermal gradient in the near-surface environment of carbonaceous asteroids is greatly reduced when compared to the lunar thermal gradient. To better understand how well physical properties can be constrained using TIR spectral observations additional laboratory studies focused on particle size distributions and porosities are needed.