Name: Casey Honniball (she/her/hers)

Code: 698

Home institution: NASA Goddard Space Flight Center/University of Maryland, College Park

Name of task: NASA VIPER Support/698.015

Role in task/ what they do for CRESST: I am a Visiting Assistant Research Scientist in the Planetary Geology, Geophysics and Geochemistry Laboratory at NASA Goddard Space Flight Center and I study volatiles on the Moon and airless bodies. I use Earth and space-based observatories to remotely measure the concentration and variations of volatiles as a function of location, age, temperature, and mineralogy. Using the NASA Infrared Telescope Facility (IRTF) on the Big Island of Hawai'i, I study the variation of hydroxyl, and possibly water, on the surface of the Moon at 3 µm. To strictly detect molecular water, I conducted observations of the Moon in the 5 to 8 µm wavelength range with the Stratospheric Observatory for Infrared Astronomy (SOFIA) in search for the 6 µm molecular water band. Using both the IRTF and SOFIA I work to characterize the amount of molecular water present on the Moon compared to hydroxyl, to investigate the variations of molecular water and hydroxyl across the surface under different illumination conditions, and to look for locations with high molecular water and hydroxyl content.

I am also a Co-I on the NASA Volatiles Investigating Polar Exploration Rover (VIPER). As a Co-I, I will compare the exchange of volatiles with the lunar surface and exosphere. I will accomplish this by determining whether volatiles exchange with the lunar surface at low temperatures on diurnal timescales or if they concentrate at high latitude and by determining the role of micro cold traps and shadows at retaining volatiles on different timescales. Using the IRTF and SOFIA I will place VIPER measurements into regional context by observing the VIPER landing and traverse area over a range of illumination conditions. Maps of the 3 µm hydration band at different times of lunar day provide regional context of hydration measured by VIPER. Additionally, VIPER's infrared spectrometer cannot distinguish between water and hydroxyl using the 3 µm band. To estimate how much water is present in the 3 µm hydration band I conducted observations of the VIPER landing region with SOFIA to map the 6 µm water band.

Background/ Autobiography: In first grade I was diagnosed with dyslexia which I believe played a huge role in leading me to my current career path. I worked hard to overcome the challenges I faced with learning. I found that I most enjoyed courses that provided hands on and direct applications such as science. As a Junior in high school, I decided I wanted to pursue physics and astronomy as a career. I started my undergraduate at the University of Hawaii at Manoa as a physics major and immediately found that the field was not for me. I decided to transfer to the University of Arizona (U of A) to major in Astronomy; this was the best decision I could have made. At U of A I joined the Steward Observatory Radio Astronomy Lab where I got hands on experience building radio telescopes to look at molecular clouds and their life cycle. This brought me to extreme places on Earth like the Atacama Desert in Chili and to Antarctica to deploy and operate radio telescopes. I completed my bachelor's degree in 2014 and went back to the University of Hawaii at Manoa for my graduate work, this time in geology and planetology.

For my master's degree I built a hyperspectral imager operating in the mid-wave infrared from 3 to 5 µm to demonstrate that coupling uncooled microbolometers with interferometers allows for quality measurements for high temperature science applications. One such application is measuring the CO2 output of the Halemaʻumaʻu lava lake. For my Ph.D. I focused on lunar observations with Earth-based telescopes, measuring hydroxyl and water on the surface. I used the IRTF to study the variation of the O-H bond at 3 µm and found that the band varied diurnally and with latitude. However, there was still uncertainty around if the 3 µm band was created by solely hydroxyl, or if water also contributes. The ambiguity surrounding the responsible species led me and my graduate advisor Dr. Paul Lucey to develop a new measurement technique for directly detecting water on the Moon using water's fundamental infrared bending mode at 6 µm. At the time, there were no observations of the Moon near 6 µm and no spacecraft were capable of 6 µm lunar observations. The only observatory capable of such measurements was SOFIA and we conducted the first observations of the Moon in search for waters 6 µm band in 2018. We found the first unambiguous detection of the water molecule on the sunlit Moon from these observations and since then have observed roughly three quarters of the nearside with SOFIA and are looking at how water varies with temperature, latitude, and composition.

Selected Publications:

Reach, W. T., P. G. Lucey**, C. I. Honniball**, A. Arredondo, and E. R. Malaret. 2023. "The Distribution of Molecular Water in the Lunar South Polar Region Based upon 6 µm Spectroscopic Imaging." The Planetary Science Journal, 4 (3): 45 [10.3847/psj/acbdf2]

Arredondo, A., **C. I. Honniball**, P. G. Lucey, et al. 2023. "SOFIA+FORCAST Lunar Legacy Project Processing Procedure." Publications of the Astronomical Society of the Pacific, 135 (1044): 024501 [10.1088/1538-3873/acb1d6]

Honniball, C. I., P. G. Lucey, A. Arredondo, W. T. Reach, and E. R. Malaret. 2022. "Regional map of molecular water at high southern latitudes on the Moon using 6 µm data from the Stratospheric Observatory For Infrared Astronomy." Geophysical Research Letters, [10.1029/2022gl097786]

Honniball, C. I., et al. (2020). Molecular water detected on the sunlit Moon by SOFIA. Nature Astronomy, [10.1038/s41550-020-01222-x]

Honniball, C. I., et al. (2020). Telescopic Observations of Lunar Hydration: Variations and Abundance. J. Geophys. Res.: Planets, 125 (9), [10.1029/2020je006484]

Honniball, C. I., R. Wright, P. G. Lucey, and A. S. Khayat, (2020). Evaluating the spectroradiometric performance of an uncooled midwave infrared hyperspectral interferometer using a microbolometer array detector. Optical Engineering, 59 (07), [10.1117/1.oe.59.7.074103]

List of awards won:

2020 Best SOFIA Thesis of the Year
2018 UH Graduate Division Graduate Achievement Award
2017 AGU Outstanding Student Poster Award, 2017
2014 Williams F. Lucas Astronomy Scholarship

To learn more about Casey's work or for collaboration, she can be reached at:
casey.i.honniball@nasa.gov